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VOLUME 9, No. 3 MARCH 1957

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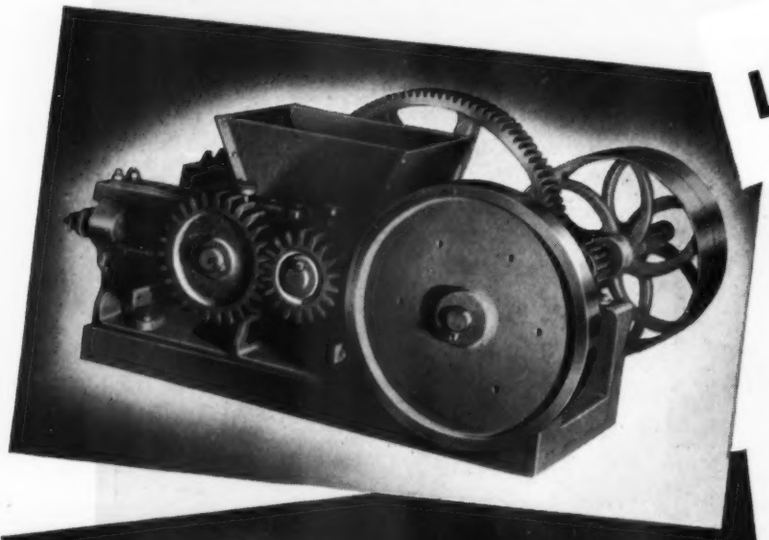

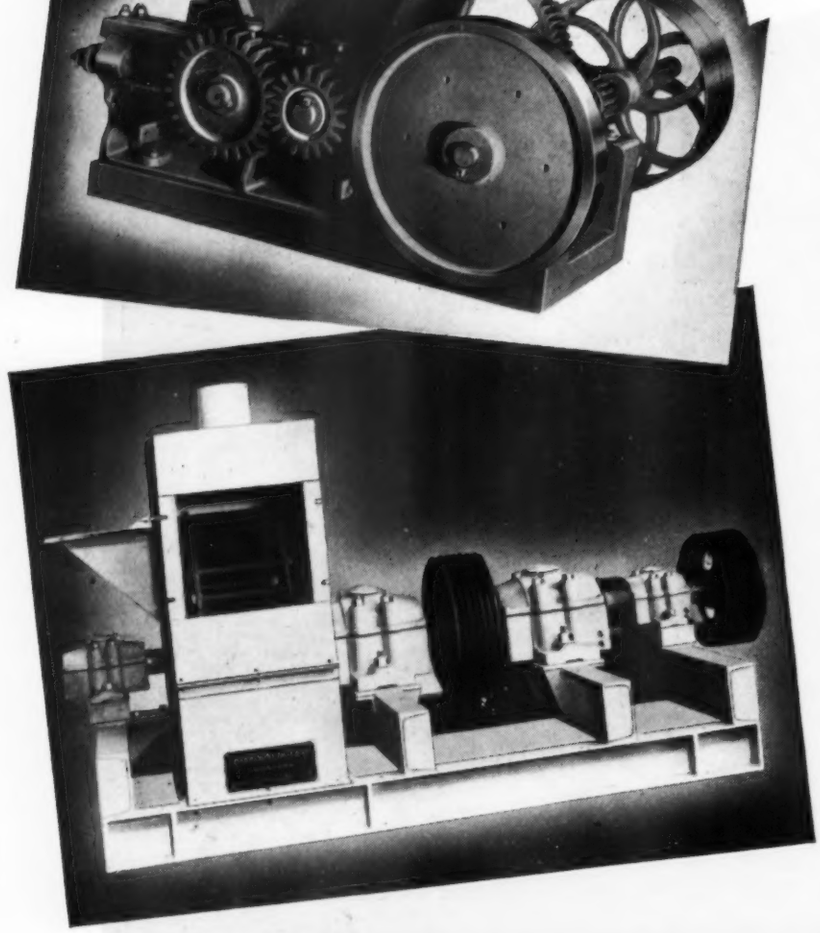

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WORLD CROPS

Vol. 9, No. 3 MARCH 1957

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The front cover illustration depicts hand weeding in sugar cane in Mauritius.

A new method is the use of PALORMONE D, a well-tested and efficient sugar cane selective weedkiller.

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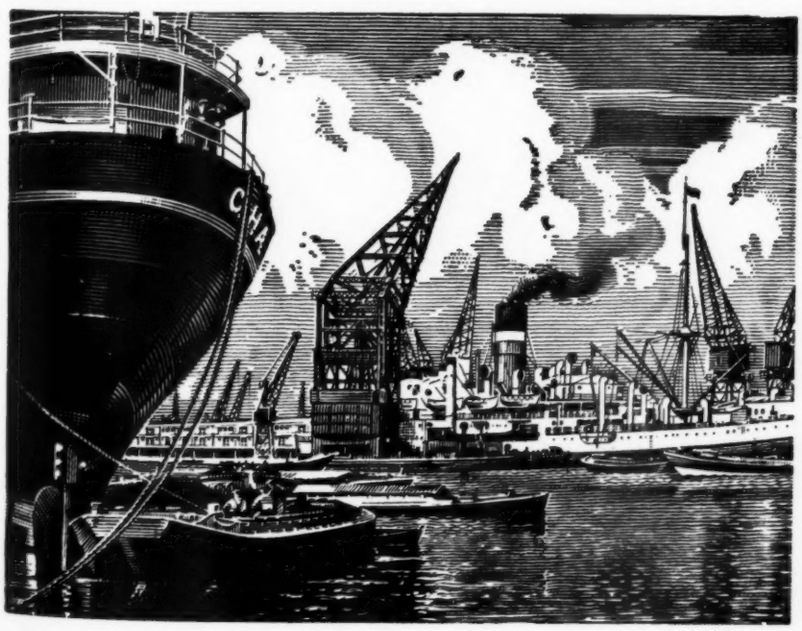

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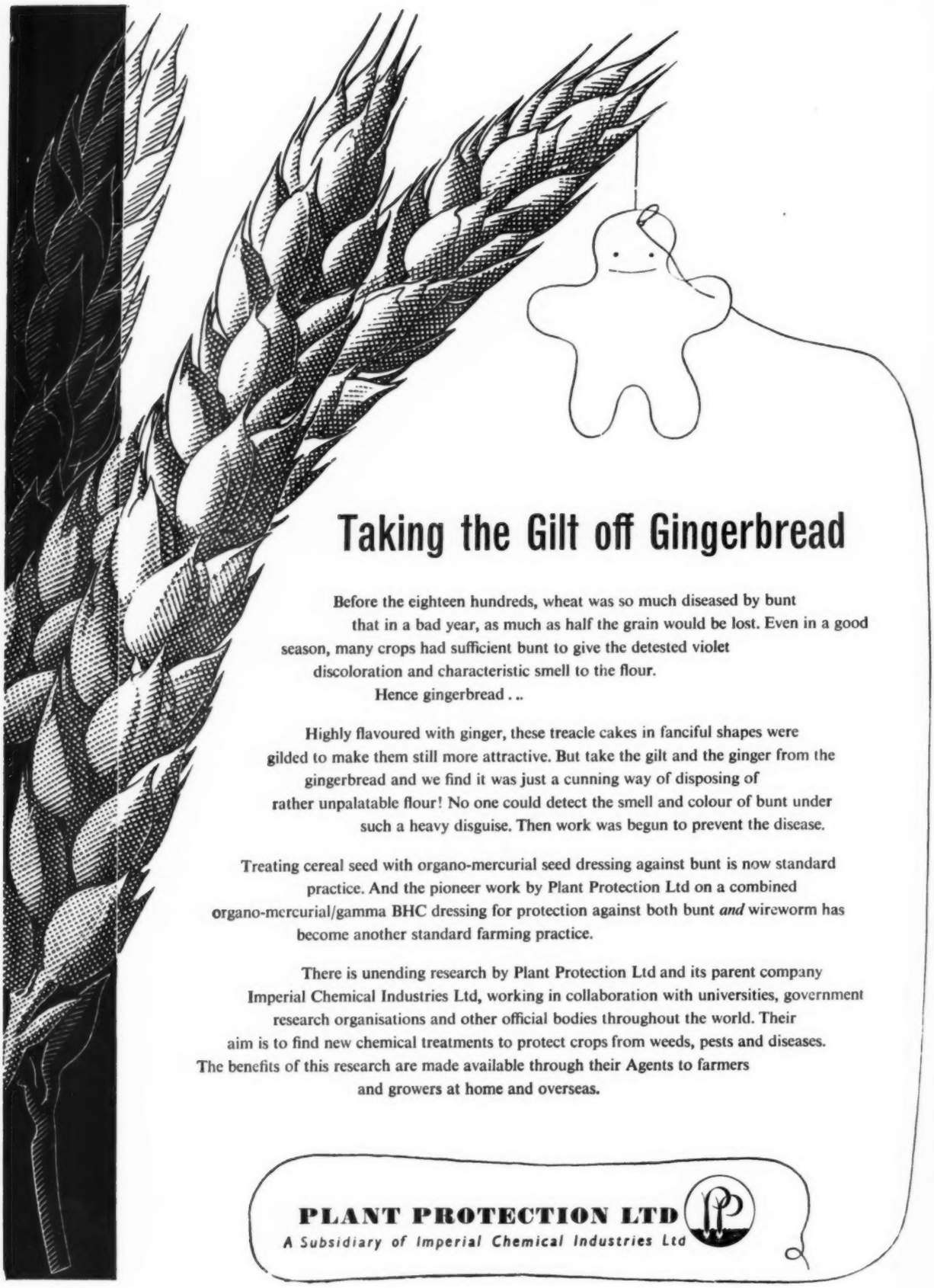

Taking the Gilt off Gingerbread

Before the eighteen hundreds, wheat was so much diseased by bunt that in a bad year, as much as half the grain would be lost. Even in a good season, many crops had sufficient bunt to give the detested violet discoloration and characteristic smell to the flour.

Hence gingerbread . ..

Highly flavoured with ginger, these treacle cakes in fanciful shapes were gilded to make them still more attractive. But take the gilt and the ginger from the gingerbread and we find it was just a cunning way of disposing of rather unpalatable flour! No one could detect the smell and colour of bunt under such a heavy disguise. Then work was begun to prevent the disease.

Treating cereal seed with organo-mercurial seed dressing against bunt is now standard practice. And the pioneer work by Plant Protection Ltd on a combined organo-mercurial/gamma BHC dressing for protection against both bunt *and* wireworm has become another standard farming practice.

There is unending research by Plant Protection Ltd and its parent company Imperial Chemical Industries Ltd, working in collaboration with universities, government research organisations and other official bodies throughout the world. Their aim is to find new chemical treatments to protect crops from weeds, pests and diseases. The benefits of this research are made available through their Agents to farmers and growers at home and overseas.

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Editorial Comment

Arid zone research

THE 'Australia–UNESCO Symposium on Arid Zone Climatology with special reference to Microclimatology' was held in Canberra recently. Some 30 experts from 16 overseas countries actively interested in desert research attended, together with scientists from Australia.

Mr. R. G. Casey, the Minister in charge of C.S.I.R.O., who opened the Conference, said that Australian research on reducing evaporation from reservoirs and on rain-making would benefit all countries with water shortages. Mr. Casey referred briefly to C.S.I.R.O.'s 'Mansfield process', which uses cetyl alcohol to limit evaporation from reservoirs and dams, and said that Australia expected to save a great many millions of pounds a year by its application. Details of the process would be made freely available to other countries. He went on to say that another contribution Australia might be able to make to the Conference was in the work on artificial rain-making that has been done by Dr. E. G. Bowen and his C.S.I.R.O. Division of Radiophysics. They believed that they were close to achieving practical and economic results in that field. He could conceive of few greater boons to mankind than the ability to encourage rain from reluctant clouds.

Sir Ian Clunies Ross told the Conference that Australia has more than its share of the arid areas of the world; it is, in fact, the driest continent. North America, Europe and Asia receive average rainfalls half as great again as Australia. Africa has twice as much rain as Australia, and South America three times as much. Three-quarters of Australia falls in the arid zones.

Sir Ian pointed out that Australia is fortunate that her arid areas still retain a comparatively dense plant cover, which makes her desert areas unique. She has escaped the pressure of population in her arid areas that occurs in the dry lands of the Old World. She must make sure that her arid and semi-arid areas are not used beyond their capacity, with the inevitable result of increasing aridity.

Saving water in dams

REDUCTION of evaporation losses in dams and reservoirs is of particular importance in Australia's arid and semi-arid areas. The Mansfield process, previously referred to, provides farmers with a simple method for cutting evaporation losses by one-quarter or more.

The process uses beads of an insoluble chemical called hexadecanol (cetyl alcohol), which are contained in a gauze basket in a special raft, which is anchored in the dam. Hexadecanol is a white waxy solid, which floats on water and produces a very thin invisible film, which spreads from the beads over the surface of the water, and this film restricts evaporation.

The film slowly disappears from the water surface, but it is replenished from the beads stored in the raft; they also supply additional hexadecanol to renew the film if it gets broken.

The process is, for the present, recommended only for sheets of water of up to 2 acres in extent. On dams of up to 1 acre in area one raft is sufficient, but for dams between 1 and 2 acres in extent two will be needed. On larger areas than this, wave agitation is greater and can rapidly break up and dissipate the film of hexadecanol.

The specification of the C.S.I.R.O. calls for beads about $\frac{1}{8}$ in. in diameter and it also provides for the hexadecanol to be of a specific chemical purity. Full details of these specifications and of the gauze basket and the approved type of raft are given in C.S.I.R.O. leaflet, series No. 15, published in Melbourne in 1956.

The ivory towers

THE late Prof. C. E. M. Joad set himself the important task of interpreting science to the layman. His articles and talks on the radio were always presented in popular form, but there were scientists who resented this, who honestly felt that he was debasing science, and that he was communicating to the uninitiated the secrets and mysteries of their craft.

Now, with the steady increase in specialisation and the development of new branches of scientific investigation, it is becoming increasingly necessary for the scientist himself to keep abreast of progress in other fields of work and in turn to make his work available to others specialising in different fields. It is perhaps as important that the scientist and the technician should be kept informed as it is to educate the layman. There is, however, an almost insuperable barrier in that few scientists are willing or able to express themselves briefly and in simple and attractive language.

In a recent issue of *The New Scientist*, Barrington Yates, F.R.S., says that the scientist has two jobs—to find something out and to communicate it to others in readable form, because clear communication is as necessary as discovery. 'Our young scientists', he states, 'are highly trained to find out something; they are not highly trained—they are hardly trained at all—to write'.

It may be argued that everyone has to teach himself

to write (by writing), but he considers that the way will be made easier if, in the beginning, there has been some firm guidance in the feeling for words, so that the same ideas can be expressed in simple language and in simple terms without having to resort to cliché or the ponderous circumlocution of specialist jargon.

Readers of WORLD CROPS, whether they be administrators, agricultural advisers, scientists, chemical and plant manufacturers, agricultural merchants and contractors, insurance assessors, financiers, planters, farmers, horticulturists, fruit growers and foresters, all need to be kept informed of recent advances of knowledge and new developments in various specialist fields of research and agricultural development, and it is the obvious duty of the specialist to meet this need and not confine himself to reporting his work in the standard form in purely specialist journals.

Civilisation at the crossroads

IN the same issue* Sir Harold Hartley, F.R.S., reviews the period of rapid change in which we are living. With regard to agriculture, he says that the impact of science and invention has perhaps been less spectacular than in industry, but no less far-reaching . . . science is just beginning to break in and unravel that most complicated problem—the complex assemblage of inorganic material and organic material, both living and dead, that constitutes the soil. New discoveries are revealing the delicate balance of factors in the top few inches of soil on which fertility depends. Mechanisation, improved methods of cultivation, irrigation, improved strains of plants and animals, fertilisers, weedkillers, insecticides and fungicides are all helping to increase the output per acre and to enlarge the soil area available for food production.

He reviews the increasing needs of the world and the factors that limit Man's progress. Water he regards as the first essential—water is not only a vital factor in fertility and life; it is also a destroyer, by floods and soil erosion, and as a potent carrier of disease. So ' the water problem merges into wider issues of water control—dams and reservoirs, water power, irrigation and drainage, flood control, artesian wells, cultivation to prevent erosion, and afforestation to check run-off. . . We know far too little about underground reservoirs and the flow of water underground, even in this country '.

' The increase in productivity ', he concludes, ' is barely keeping pace, on a world basis, with the increase in numbers. In the more advanced countries, with their advantages of science, mechanisation, fertilisers and better strains, the output per acre is rising steadily, and the yield from cereal crops may well be doubled. But the real problem lies in Asia and partly, too, in Africa with their handicaps of malnutrition, land tenure traditions, their leached soils and their need for water. The fact is the gap is widening between the richer and the poorer countries, and that is the alarming feature '.

We are only able to quote a few fragments of this urgent and significant warning, which coming from such an eminent authority needs to be read *in extenso*. It brings home to us the continuous and increasing need for material aid, technical assistance and inspired leadership in the under-developed countries, particularly in those countries like China, where population increases are truly formidable. Modern methods, machinery, equipment and chemicals are urgently needed to increase their productivity. But, above all, the situation demands a much more determined approach than hitherto to the difficult problem of population control in those countries where the application of measures to relieve human suffering and combat disease are unaccompanied by birth control, and thus are leading to increases in population out of all proportion to the present fertility and productivity of their cultivatable lands.

The danger of a third world war cannot be averted merely by the fear of nuclear weapons, because desperate people are indifferent to consequences. The United Nations Organisation may possibly be able to maintain an uneasy peace for a few years longer, and agriculturists will undoubtedly continue to step-up food production, but if the problem of population continues to be shelved there can be no permanent peace. The trouble in Egypt was set off by the need for water and the necessity for financial aid to build the Aswan Dam to meet the growing needs of this growing nation; the seizure of the Suez Canal appeared to offer a solution. A similar situation is building up in China with its population of 600 millions, increasing at the rate of 1,000,000 every month. The problem cannot be solved by its economic isolation. Sooner or later this problem, too, will have to be faced. The amber light has shone on four occasions; it has now turned to red. We have been warned.

Farmers, population . . . and food

WORLD population now stands at approximately 2,500 millions; in 20 years' time it is likely to be 3,000 millions; and at the end of the century, if no unforeseen calamity occurs and the present rate of acceleration is maintained, it is likely to be 3,800 millions, according to 'Agriculture in World Economy', a publication issued by FAO in 1956.

About three-fifths of the present population, *i.e.* 1,400 millions, live on farms, but the proportion in different countries varies considerably. Thus in Siam 85% of the active population live on farms; in Brazil, 57%; in France, 36%; in Holland, 19%; in the U.S.A. it is 11%; and in Britain it is only 5%.

* *The New Scientist*, No. 5, 1956, ' Problems and Prospects in Industry ' by Sir Harold Hartley, F.R.S.

Otherwise expressed, in Britain one active agricultural worker produces for 20 people, whose food has still to be supplemented from outside sources; in Siam one adult farm worker produces only enough for 1.1 adults, and this is little more than mere subsistence agriculture.

World food consumption, measured in terms of calories per head, has in recent years been slightly less than before the war. Only in Africa and Latin America —countries which were hardly affected by the war— are food supply levels higher than before.

According to the Monthly Bureau of Economics and Statistics, published in October 1956, total supplies of oils and fats and milk and sugar have increased and the production of cereals has declined. In all countries, except the U.S.A. and Latin America, protein consumption per head has declined.

Expressed in figures, the intake of calories in Latin America is up by 10%; in the Far East it is down by 8%. In Western Europe it is down by only 1%; in Oceania it is down by 8%. The protein consumption per head is up by 2% in North America; it is down by as much as 11% in the Far East.

Flame cleaning

IN the height of a sowing season keeping drills thoroughly clean is more easily advised than done. However, the main risk of abnormal corrosion comes from leaving a drill crusted with fertiliser when it is put away at the end of a sowing season. A new means of achieving a thorough cleaning of drill surfaces speedily and simply is being developed—flame-cleaning with oxy-acetylene gas. As an anti-corrosion practice, flame-cleaning is already accepted in industry; it is only its potential use with farm appliances that is novel. Flame-cleaning burns off volatile material and moisture and it penetrates into pits and crevices more deeply than any other method of surface treatment. Effective demonstrations of flame-cleaning badly encrusted drills have been impressive, and we understand that a commercial film on this subject has been produced. After flame-cleaning, the drill is given a coating of oil or other rust-protecting liquid before storing it away.

How far farmers themselves would be prepared to buy flame-cleaning equipment is difficult to judge. The outlay is not high, perhaps something in the region of £50–60; to this must be added the running cost of the necessary cylinder-contained gases. On larger farms where several drills are used each sowing season, the investment might be well justified. Local contracting services would seem to be a sounder approach for the small farm, where perhaps only one drill or at the most two are used. If the new method is as good as its sponsors claim, there seems to be quite an opportunity here for merchants or agricultural engineering contracting firms.

Commonwealth research

A SUBJECT of intense future significance—especially for overseas agriculture—is raised in the latest Annual Report (1955–56) of Britain's Advisory Council on Scientific Policy. This is the means by which scientific personnel can be made available to former colonial territories which become self-governing countries within the Commonwealth. The recommendation made by the Advisory Council is direct and simple—that the best method of giving scientific help to independent territories is to make it available from the same sources used for the colonies, *viz.* the Colonial Office.

This seems far preferable to the more cumbersome method of creating a new and separate system. The only problem is that of payment. Obviously for work in a self-governing territory costs cannot fall upon the Colonial Office; this would seem a small problem to overcome and no doubt self-governing territories would welcome the opportunity of paying the British Government all costs for scientific aid seconded to them. It would, indeed, be a Commonwealth of precarious goodwill that could not settle this detail of book-keeping amicably.

The Advisory Council on Scientific Policy goes on to urge Research Councils here to give new thought to measures for developing their overseas activities. Emphasis is laid upon the need for an Institute of Tropical Agriculture as a centre of research and expert knowledge. There is at present no centre which could serve as a base for British students who wish to develop a future career in tropical agriculture; at the same time, such a centre could also be used for training or advising citizens of the new self-governing countries. It is not suggested that the proposed Institute should be in Britain—the right place is in some suitable tropical area. That these points, put forward by the Advisory Council, are both wise and timely will hardly be disputed by men of sense and imagination.

Better seeds, better crops

AT this season many agriculturists and horticulturists will be thinking of their seed requirements for the year. The use of good reliable seeds is of great importance, and it is not generally realised how inferior the produce from cheap seed is when compared with that grown from pedigree seed. There are often many different strains of the same variety, varying from very good to almost worthless. This is another reason why it pays to buy only the best seed. They may be slightly dearer than other seeds but in the long run they more than repay their cost.

Only too often, however, growers blame the quality of the seeds if they fail to make good growth, when, in fact, the fault is cultural. Before seeds will grow, they must have sufficient moisture and air and a

suitable temperature. In addition, they must be planted at the correct depth for, if set too deep, they may germinate, but not having sufficient food reserves within the seed, may fail to reach the surface and so die. Alternatively, if planted too shallow, the seedlings may become dried up by sun and wind before their roots reach the safety of moisture in the lower layers of soil.

Insect and fungus pests may also attack the seedlings before they reach the surface of the soil and the seed is often blamed when, in fact, pests and diseases have been the cause of failure.

Certified seed

THE Seed Production Service of the Cyprus Department of Agriculture announces that it has this year processed 4,000 tons of cereal seed from growers whose crops have been field-inspected, certified, mechanically cleaned and automatically treated with fungicide.

Approved growers are supplied with seed of a high quality and their crops are kept under constant supervision by officials of the Seed Production Service. Those crops which come up to the required standard on field inspection are certified and growers receive a price of £2 a ton above the rates paid by the Grain Commission. The certified seed is then collected and taken to the stores of the Seed Production Service in Nicosia, where two seed-cleaning machines, each with a capacity of three tons an hour, work 12 hours daily preparing the seed for distribution to approved farmers throughout the island.

At the same time as it is cleaned of impurities, the seed is treated with a powdered fungicide which prevents the spread of seed-borne diseases. It is distributed to farmers through village co-operative societies in sealed bags.

Many farmers have come to rely on the seed supplied by the Department of Agriculture as one of the major aids to bumper crops.

Frost-resisting wheat

A NEW hard red winter wheat seed, which will withstand the sharpest frost, was announced after 12 years of development and trial. Last year the new seed withstood temperatures of –35° C. without damage during tests in East Anglia. As from 10–100% of our wheat crop is said to be lost each year through frost, it seems likely that this new wheat may revolutionise British farming.

In addition, it is said to have superb milling qualities; its yield per acre is estimated at 30 cwt., and it can be sown 10 days earlier than most varieties. It seems likely, therefore, that this new wheat seed—known as ALG 42—will be in high demand. Unfortunately, it will at first only be available in small quantities.

Fuel economy

THE economy of the diesel engine, which is particularly important at the present time, when fuel is in such short supply, is well illustrated by figures supplied by 12 local authorities.

Fuel consumption records, relating to both petrol- and diesel-driven vehicles engaged in refuse collection, show a weekly saving per vehicle, using diesel oil, of £4 3*s.* 11*d.*

The average rates of consumption of fuel per week per vehicle were 31 gal. with petrol and only 13 gal. with diesel oil—a net saving of 18 gal. per vehicle. This not only means a considerable financial gain to the farmer if he uses diesel-driven farm vehicles, but it also represents a material contribution in fuel economy during the present crisis.

Higher prices for farm products

THE ECE review of conditions in Western Europe concludes with a discussion of current trends in agriculture. The general upward drift of farm prices is noted and the report suggests that in many of the Western European countries governments are faced with increasingly difficult problems in the field of agricultural policy. Increases in wages of farm workers in many countries and other increases in farming costs or in general price levels have produced during the last year widespread demands for higher prices for farm products. To accede to these demands in present conditions frequently involves either a higher tariff or tighter import restrictions or, alternatively, an increase in the subsidy bill.

However, any of these solutions are liable to lead to further difficulties—either a new upward pressure on the general price level, subsequent wage increases and a strengthening of any existing tendencies towards a cumulative cost inflation or an increased burden on the budget and possibly a need for offsetting economies in other expenditures, or for tax increases.

The Secretariat suggest that the most energetic pursuit of such policies can as yet offer little prospect of any immediate change in the general upward drift of food prices and claims by farmers' organisations for new price increases in the 1956–57 season have already been made or can be foreseen in Western Germany, the Netherlands, Switzerland and the U.K.

Increases in the general level of farm prices do not in themselves provide any incentive to increase productivity, the report suggests, and the atmosphere of protection may, in fact, discourage efforts in this direction. However, some governments are apparently becoming increasingly discriminating in the measures used to support the real income of the agricultural sector, with the aim of encouraging greater efficiency and a more selective expansion of output.

GRASSLAND IMPROVEMENT

GORDON WRIGLEY, B.SC., A.I.C.T.A.

(*Chesterford Park Research Station, Fisons Pest Control Ltd.*)

The 10% of the earth's land area that is cropped produces 90% of the world's food supply. The 20% of the earth's land area that is covered with grassland produces the remaining 10%. These striking facts illustrate the gross under-productivity of the world's grassland. If the productivity of pastures is to be improved, the measures already being taken in some countries, and surveyed in this article, will have to be adopted more widely.

IN the Netherlands, grassland management is sufficiently well advanced that it produces the same yield of fodder units as arable land, but there are very few other countries in the world where the grassland gives anywhere near this high productivity figure. To increase the productivity of arable crops in England would require a substantial effort, but by improved management, based on the liberal use of fertiliser, controlled grazing and the eradication of unproductive plants such as bracken, ragwort and thistles, the productivity of British grassland could easily be doubled.

Overseas, where the vast grazing areas such as the Llanos, Pampas and Veldt are natural grassland, unfenced, and grazed on an extensive system with a low animal population, how much greater are the possibilities for increased production from the improvement of grassland and how necessary is it going to be to obtain ever-increasing food supplies from these reservoirs as world population continues to increase.

The improvement of grassland is an interaction of many factors. In many parts of Africa the system of land tenure does not give the cattle owner sufficient security of tenure or sole right to a grazing area to warrant the expense of improvement. Many of the grazing areas are for communal use—unfenced and frequently overgrazed—with a rapidly declining productivity, and until this sociological problem has been dealt with, little progress can be expected. In addition, the value of livestock products must be sufficient to stimulate increased production. The African's 'backyard hen', producing 50 eggs a year for nothing, is a more attractive proposition than the hen laying three times that number but eating expensive food or food which the owner himself can consume. Given the support of these sociological and economic factors, together with adequate water facilities, the next essential to grassland improvement is fencing to enable the grazing to be controlled and, in some cases, the protection of improved pasture from a neighbour's cattle. Having obtained this control of the biotic factor in grassland, management, the key to grassland farming, can be effective.

Cattle grazing on pasture land in Southern Rhodesia

It is easy to say that by good management, good weed-free pastures can be maintained at a high level of productivity but it is much more difficult to accomplish this, as the poor state of much of Britain's permanent grassland bears witness. The number of grazing animals remains relatively constant throughout the year yet the productivity of all non-irrigated pastures fluctuates widely. The rains may be late in starting or light as in 1945, when the drought in Algeria caused the death of seven million sheep and, about the same period, a series of dry years in Australia led to a considerable reduction in the sheep population. Following a reduction in livestock numbers resulting from drought or epidemic, there is a more rapid reversion of savannah to bush, which is uncontrollable. Only under the more intensive systems of farming is it conceivable to feed the livestock in times of scarcity or mow the grass in times of plenty. Dramatic differences are shown in crop production and grassland growth in the tropics when the same rainfall occurs on 90 days of the year rather than on 120.

In the majority of the extensively grazed, natural pastures of the world we are still living in an age of steady decline in productivity. The natural

pastures in the Western division of New South Wales supported over 16 million sheep in 1891 but during the next ten years of pasture mis-management the number the area could support fell to 5½ million and it has not been possible to support half the 1891 population since. Apart from the replacement of productive grasses by inferior or unproductive species, only three-quarters of what livestock consume is returned to the soil.

Encroachment of pastures

The invasion of pasture and rangeland by noxious weeds, scrub and poisonous plants is one of the most difficult and troublesome problems of graziers. Visitors to Scotland and the Lake District will see the steady encroachment of bracken on the lower slopes slowly driving out the sheep whilst in the more fertile valleys the yellow flowers of the poisonous ragwort are an ever-increasing menace to the cattle owners' livelihood.

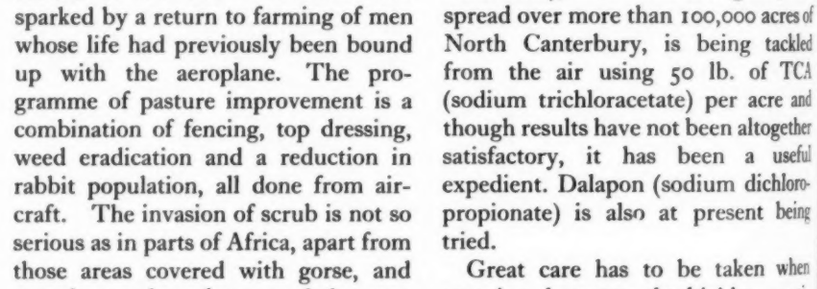
Nearly one-third of the area of Texas in the U.S.A. is infested with mesquite (*Prosopsis juliflora*); and in South Africa 2½ million acres of grazing have already been lost to thorn scrub, largely *Acacia* species, and there is serious encroachment on a further 5 million acres. In Nigeria large areas of communal grazing are being ruined by the invasion of *Acanthospermum hispidum*. Scrub encroachment is a problem common to all parts of Africa where the best land is taken for cultivation and the biotic factor is disturbing the ecological balance of the remainder to a state of lower productivity and lower carrying capacity. In many parts, the position is becoming acute due to rising population density and an increased wealth reflected in a greater number of cattle owners. In the past, the balance has frequently been restored by outbreaks of diseases like Trypanosomiasis and Rhinderpest but these are now coming under control.

Although the result is not so striking and rarely accompanied by overgrazing, this reversion to scrub goes on in more temperate areas. On many farms in the dairying area of Eastern Canada, which have been carved from the forest this last century, small areas difficult to graze or mow have reverted to scrub, but this problem is now being tackled by the more progressive farmers using 2,4,5-T herbicides. Similarly, over a million and a half acres of Texas have been sprayed with 2,4,5-T from the air and reclaimed from mesquite. This hormone herbicide is undoubtedly a valuable aid for restoring the favourable balance of a pasture which is reverting to scrub. It is cheap, easily applied and effective in small dosages. For extensive rangelands heavily encroached, aerial application is practicable, and in most intensively farmed areas spot treatment by knapsack or hand lances operating from ground spraying machines is a simple matter.

Aerial spraying in New Zealand

In New Zealand, extensive measures are being taken to deal with the steady decline in productivity discussed above, and in dealing with rangelands, New Zealand is giving a lead to the world. Much of the grazing land, particularly that used for sheep, is steep and not easily accessible and the aeroplane has been developed as a 'farm machine'. This development started at the end of the last war sparked by a return to farming of men whose life had previously been bound up with the aeroplane. The programme of pasture improvement is a combination of fencing, top dressing, weed eradication and a reduction in rabbit population, all done from aircraft. The invasion of scrub is not so serious as in parts of Africa, apart from those areas covered with gorse, and experiments have been carried out to eradicate the gorse by aerial spraying of 2,4,5-T. Aerial spraying of pastures has been mainly against the variegated thistle (*Silybum marianum*) and winged thistle (*Carduus tenuiflorus*), also burr clover, lupin, ragwort and broom. By 1955, 80,000 acres had been sprayed using up to 1 lb. of 2,4-D in 3–4 gal. of diesel oil. An oil formulation was chosen as this gave a more even droplet size and had a lower surface tension, with a superior spread and penetration of the waxy cuticles of the thistles. The oil formulation did not evaporate under conditions of low humidity. Spraying has generally to be confined to the early hours of the morning under conditions of low convection. The cost of application, including the chemical, has been around 25*s.* per acre. Satisfactory results have been obtained spraying through autumn, winter and early spring. Ragwort, which infests much of the inaccessible back-country areas, is now being tackled using a low volatile 2,4-D ester at about 2 lb. acid per acre, but this is a more expensive treatment and results have not always been satisfactory. Nassella tussock (*Nassella trichotoma*), an undesirable grass, now spread over more than 100,000 acres of North Canterbury, is being tackled from the air using 50 lb. of TCA (sodium trichloracetate) per acre and though results have not been altogether satisfactory, it has been a useful expedient. Dalapon (sodium dichloropropionate) is also at present being tried.

Great care has to be taken when spraying hormone herbicides, particularly if volatile esters are used, as damage has occurred as far away as 15 miles from the site of spraying under



'Phenoxylene Plus' being applied by a Hiller helicopter for rush control etc.

Rush-spraying operation with a 200-gal. Universal machine in difficult country at Dolfer Hill, Montgomeryshire, in Wales

unfavourable conditions and it is obviously essential to use non-volatile herbicides when susceptible crops are being grown in the area. The helicopter has also been used in trials for weed control work in New Zealand but the cost of operating is so much higher than that of fixed-wing aircraft that its use is likely to be confined to spot treatment and spraying the more intensively cultivated areas, also smaller fields as occur in the U.K.

Twenty fixed-wing aircraft are now used entirely for aerial spraying of herbicides in New Zealand but this is only a small proportion of the 300 fixed-wing aircraft which are used in the whole extensive programme of pasture improvement. Half these aircraft are Tiger Moths but they are being replaced with aircraft with a higher pay-load and specially adapted for New Zealand conditions.

Other aerial operations

There is little point in eradicating the weeds unless the space is occupied by more productive herbage. Much of the soil in New Zealand responds remarkably to the application of phosphate which in many countries is the key to grass production. The aerial application of phosphatic fertilisers is a most amazing development. Apart from the Bristol freighters with their large seven-ton pay-load operating from aerodromes, there is a vast fleet of small aircraft which use a large number of grass landing strips about 130 yd. long maintained by the farmers. The farmer brings the superphosphate to these strips and arranges the loading, which is frequently done mechanically. The De Havilland Beaver aircraft can release 1,800 lb. of superphosphate in two or three minutes and reloading is even quicker. The aerial operation starts at dawn and continues as long as flying and dropping conditions are suitable. Conditions normally restrict dropping operations to about 120 days a year. The aerial application of fertiliser has given a very even distribution on the ground to areas where it was not previously practicable to apply phosphate, and the response in productivity has been tremendous. Pastures previously carrying one sheep to the acre are now supporting five sheep to the acre. In the 1955–56 season, 405,000 tons of phosphate fertiliser were applied from the air, nearly five times the amount applied in the 1951–52 season. Seeding from the air and the dropping of rabbit poison has also gone ahead rapidly and the use of aircraft for the dropping of posts and fencing material is making it possible to divide up the vast grazing areas for controlled and more intensive use.

The pastures of New Zealand are also menaced by grass grubs and other pasture pests controllable by DDT and BHC. In the 1955–56 season, 375,000 gallons of insecticide were sprayed from the air on pastures.

These courageous methods must, in the years to come, be applied to the natural grasslands of North and South America and Africa, otherwise the national incomes from these productive areas will show a slow and steady decline.

Pasture spraying in Argentina has progressed very rapidly and about a million acres are being sprayed annually. This will help to raise the productivity of the grassland which is at present only producing about 10% of the country's exports, compared with the 40% contribution of cereals from a considerably smaller acreage.

Phosphate applications

The New Zealand approach to grassland improvement utilises a basic method applicable to the majority of grasslands in the world. The phosphate applied stimulates the clover growth, particularly in the seedling stage and during the spring, and the nitrogen fixed in the root nodules of these clovers in turn stimulates the grass. The growing of clover with grass has been shown in New Zealand to yield six times as much grass as compared to a pure stand of grass.

In Australia, the application of 2 cwt. of superphosphate per acre in three consecutive years increased the

total production eight times, the phosphate content sixteenfold, the nitrogen accumulation tenfold and the carrying capacity of the pasture was increased from two acres per sheep to five sheep per acre in the three years. The stimulation of sown pastures in Australia, where the use of phosphatic fertilisers on grassland has increased rapidly since the war, has also eliminated indigenous and less valuable grasses, probably on account of their not being able to stand the competition and the more frequent grazing. St. John's Wort (*Hypericum perforatum*) has been eradicated from pastures by the encouragement of subterranean clover and grass by phosphate application.

The type of grazing animal will also influence the weed population. In South Australia, Salvation Jane (*Echium plantagineum*), a weed of high protein and calcium content is avoided by dairy cows but readily grazed by sheep. Wherever practicable, the maximum output of the grassland and the best weed control will be obtained by grazing with mixed stock.

The application of fertiliser, with more intensive grazing, unaided by herbicides will, in many cases, eradicate low-fertility weeds, such as cat's ear, cudweed, daisy, dandelion, ox-eye daisy and ribgrass; but in their place come docks, buttercups and thistles, which are very difficult to remove by management, and it is here that the herbicides are of particular value. The clover content of these more fertile pastures is extremely valuable and it is essential to eradicate the weeds by using the most selective hormone preparations available, hence 2,4,5-T and the esters of 2,4-D are not generally recommended unless the weeds present do not respond to the more selective salts and amines of MCPA and 2,4-D. In many parts of the world the very selective salt formulations of MCPA have been used to remove thistles, ragwort, soft rushes and many other weeds without any permanent reduction in the clover content from improved pastures, though in some cases farmers have depressed their clovers when impure formulations or excessive dosage rates have been used or the spraying has not been combined with fertiliser application and careful management.

Grazing hazards

Poisonous plants still continue to take an annual toll of livestock and there is no reason whatsoever why this loss should not be completely eliminated by the use of hormone herbicides. The number of plants poisonous to livestock occurring in pastures is much greater than is frequently realised; 180 species have been recorded in South Africa alone. There seems to be little point in fencing, fertilising and generally improving the pasture if nothing is done to eliminate both poisonous and unproductive weeds.

Heavily infested buttercup pasture being grazed in an English meadow

In New Zealand barley grass (*Hordeum murinum*), an annual grass with barbed seed heads that cause damage to sheep, has increased in distribution and prevalence as the fertility of the pastures has been raised. In the past 10–15 lb. TCA has been used quite successfully to remove this weed, but in recent research the use of 1–2 lb. dalapon per acre applied in low volume has given excellent control of barley grass with little effect on established clovers and valuable grasses, such as ryegrass and cocksfoot. This low rate of dalapon has little residual action in the soil and the area treated can be oversown immediately after eradication of the barley grass.

Use of selective weedicides

The methods described above for improving the carrying capacity of pastures and reducing the weed population apply mainly to grassland which it is not practical to plough up and reseed. By far the quickest and most effective way of increasing productivity is by using well-fertilised short leys. Frequently a young ley comes up very weedy, but by the use of selective herbicides there is now no need for farmers to tolerate these weeds and allow them to utilise the valuable fertiliser and crowd out the clovers and grasses. The dinitro herbicides are selective to the clovers and grasses and do an excellent job of removing annual weeds from new leys. Many farmers, however, prefer to spray a more pleasant material and there is an increasing tendency to use hormone herbicides which can also eradicate perennial weeds. Pure formulations of the MCPA salt, if carefully used at low dosage rates, will remove easier-to-kill weeds without damaging the seedling clovers. 2,4-D is not recommended where red clover is included in the ley.

Two new herbicides based on the work of Professor Wain, namely, MCPB and 2,4-DB, show considerable promise for use on leys. Both these chemicals show a higher degree of selectivity than their better-known counterparts, MCPA and 2,4-D, and in particular, clovers show a high degree of tolerance. Rates up to 2 lb. per acre have been applied to seedling clovers at the one true leaf stage without causing damage. At these rates many of the more common weeds, including some of the *Polygonum* spp., which are fairly resistant, at safe dosage rates, to MCPA and 2,4-D, are controlled.

Crops of clover and lucerne that are grown for grazing, hay, silage or seed can be kept weed-free using dinoseb or the hormone herbicides 2,4,5-T is

extremely toxic to clover and when it is used in scrub and brush control it will generally eliminate the clovers of the sprayed area. Great care, however, has to be taken in using hormone preparations in spraying clover crops being grown for seed. When the time interval between spraying and seed setting is too short there is a serious depression in seed yield. There are indications that this effect occurs with MCPB and 2,4-DB as well as with MCPA and 2,4-D.

Lucerne has shown itself to be extremely resistant to 2,4-DB and, in addition, the grass weeds can be eradicated from lucerne either by using TCA at rates up to 40 lb. per acre in the dormant season or lower rates of dalapon. As for the application of most of these herbicides, the stage of growth at which the chemicals are applied is extremely important; if the growth of the lucerne has advanced too far before the dalapon has been sprayed or when climatic conditions have led to the root intake of dalapon, the lucerne has been damaged. Established lucerne has also been kept reasonably weed-free by using low rates of CMU.

Pure seed

Many of the weed problems distributed throughout the world have been created by the introduction of weed seeds as impurities in grass and clover seeds. Countries are now aware of this problem and seed producers are making increased use of herbicides to ensure supplies of pure seed for the countries' markets. Grass seed crops can be sprayed in the same manner as cereals, using similar dosage rates of the hormone herbicides, and where hormone-resistant weeds have become a problem it is quite safe to use dinitro herbicides, but these are frequently unpopular with farmers on account of the higher volume rates of application and associated toxic hazards. Research workers in the U.K. have recently discovered that many hormone-resistant weeds can be controlled by new products, such as CP1815, FB1 and CMPP. Although it is too early to predict the impact of these new discoveries on weed control in grass seed crops, there is every prospect that they will have importance in restricting further this all too common method of weed seed distribution.

Conclusion

Although the use of herbicides on grassland can never be a substitute for good management, they do enable the farmer not only to drive back brush encroachment, but to eradicate the poisonous and non-productive weeds from the improved pastures where ploughing up and reseeding is not a practical proposition. By the combined use of fertilisers, seeding, weed control and, in certain cases, the application of insecticides, the productivity of the pastures in many parts of the world can be considerably improved.

As long ago as 1798 Malthus expressed the fear that the population would outstrip food resources in the coming years. His gloomy predictions have not yet come to pass through the opening up of new and fertile food-producing areas and by improved methods of farming, particularly the use of fertilisers and new crop varieties. If the world's grasslands can be brought to their full productivity his fears should not be realised for many years to come.

Photos: Fisons Pest Control Ltd.

Better Seeds: Better Crops

Weed Control by Seed Testing

THE subjects chosen for discussion on the first day of the Fourth Annual Crop Conference were the service, influence and future work of the Official Seed Testing Station at Cambridge. The conference was attended by nearly 300 Fellows of the National Institute of Agricultural Botany. Mr. Roland Dudley, who presided, said that seed testing today was entirely different from what it was 20 or 30 years ago, owing to fundamental changes in agricultural operations. It is now not merely a matter of looking at a sample of seeds, but of applying a number of detailed tests. The following is a brief account of each of the papers given at the conference:

The Work of the Official Seed Testing Station in Relation to the Problems of Farmers and Seedsmen *by P. S. Wellington (Chief Officer, Official Seed Testing Station)*

During the year ended July 1956, 71,000 samples were submitted to the Official Seed Testing Station at Cambridge. About 10% came from farmers, 1% from Ministry of Agriculture inspectors and 89% were submitted by merchants or others selling seed. The classification of the seeds was as follows: cereals 42%, roots and vegetables 22%, grasses and clovers 15%, pulses 8%, and others 13%.

The various tests and their purpose are described. Briefly, they consist of (1) a purity test to determine the proportion of the desired seed in 3,000 seeds—the impurities are classified as weed seeds, other crop seeds and inert matter; (2) a germination test to determine how much of the pure seed is capable of producing mature plants; (3) a moisture determination to determine the correct setting of harvesting equipment, the treatment necessary to eliminate dormancy, the risk of deterioration from seed dressing and the best method of drying the seed before storage; (4) tests for seed-borne diseases—quick and easy tests are now available for about 20 diseases; (5) testing of seeds for variety difference, which is being studied.

The Statutory Tests *by L. J. Smith (Ministry of Agriculture, Fisheries and Food)*

The Seeds Act, 1920, and the Seeds Regulations prescribe the tests. The Act requires seed to be tested for purity and germination at certain places; the Regulations define pure seed and impurities, but the Act gives no guidance either on methods of testing or the apparatus to be used. Guidance in these matters is given by the Rules of the International Seed Association, a voluntary body of which the U.K. is a leading member. They try to avoid a legal approach and seek rather to help and advise the farmers and seedsmen.

Last season, Cambridge made nearly 80,000 tests; rather more tests are,

(Continued on page 117)

LEY FARMING IN THE AUSTRALIAN WHEAT BELT

A. J. MILLINGTON, D.Sc.

(*Reader in Agronomy, University of Western Australia*)

Great emphasis is given in Australia to pasture improvement, as this is considered to have great significance for the Australian wheat farmer in producing a higher yield of better-quality grain. It is considered that the results now being obtained in Australia will prove of direct value to farmers elsewhere in the world.

AUSTRALIA is a minor producer of wheat, but ranks fourth in terms of world trade. This position has been achieved largely by the expansion in acreage which occurred during the decade 1921–31, but during the subsequent quarter of a century economic pressure has acted, for the most part, towards a reduction in the area planted to wheat.

Economic factors

The bitter experience of wheat farmers during the depression years 1930–39 and the long fight for a Government guaranteed price has given them experience of the economic consequences of producing a commodity of which there is a world surplus. By contrast, wool has sold readily for cash and for a decade at prices which are relatively better, by pre-war standards, than wheat. The net return being obtained for wheat in overseas markets has steadily declined until it is now approximately equal to the calculated cost of production, which has risen progressively in recent years to 13*s.* 4*d.* (Aus.) per bushel. The decline in the net return per bushel to the farmer, despite relatively stable world wheat prices, is largely due to the sharp increases in freight rates. Whereas the charter rate to England amounted to only 2*s.* 3*d.* per bushel (Aus. currency) in 1954, it rose during the Suez Canal crisis to 7*s.* per bushel. To this must be added a further 1*s.* 4*d.* for rail freight in Australia.

In addition to the purely economic factor of price, sociological and technological developments have acted in favour of increasing livestock numbers, while reducing, or stabilising, the acreage sown to wheat. The human birth rate on wheat farms tends to be lower[1] than that of the community as a whole, and this, combined with the post-war shortage of experienced farm-hands, has made labour a very scarce and expensive commodity. Farm operations have been planned, consequently, to minimise the necessity for seasonal non-family labour and with more prosperous times farmers' wives have become increasingly reluctant to accept the additional housework and loss of privacy that follow from the employment of outside labour.

The economic and sociological pressures have created a climate very favourable to technological change and most farmers are sufficiently well provided with the necessary financial resources to enable them to adopt new practices.

Increase in sheep

The most important development has been the increase in sheep numbers, so that an increasing proportion

Effects of subterranean clover ley at Rutherglen Research Station, Victoria. (Left) *Wheat on regularly cropped land (on fallow). Average yield for the four years* 1951–54, 12.8 *bushels per acre.* (Right) *Wheat after two years' clover pasture (without fallow). Average yield for the same four years,* 22.1 *bushels per acre*

of the farm income is being derived from this source. In Western Australia, for instance, where the acreage sown to wheat has remained relatively stable, 9 million sheep are now kept on wheat farms. This represents an increase of 50% since 1940 and they probably provide their owners with a net income of some 30 million pounds per annum, as against 20 or so million pounds to be expected from cereal crops.

With the increase in sheep numbers there has come a demand, not only for bigger areas of pasture, but also for more productive leys. The increase in area under pasture has been achieved partly by the aggregation of small farms into larger ones and partly by a reduction in the area under bare winter fallow as the preparation for the succeeding wheat crop.

The area on the left had been under lupins for the three years previous to autumn ploughing, while the area on the right had been used in each of the three years for oats sown annually for grazing. The improvement in soil structure following the legume is shown by the improved aggregation

Elimination of winter fallow

The desirability of minimising the area under fallow has been demonstrated by the now classical experiments conducted by the State Department of Agriculture at Rutherglen in north-eastern Victoria. These showed that the nitrogen-rich organic matter accumulated during a period of clover ley produced more wheat and sustained yields better when crops were planted in succession rather than by preceding them by bare fallow. When three courses of fallow-wheat were used, only about 25% of the nitrogen lost from the soil was removed in the grain, whereas when six successive crops were taken, over 40% of the nitrogen loss was recovered in the grain.[2]

Experiments conducted by the West Australian Department of Agriculture have shown that, due to the rapid breakdown of the clover residues, fallowing of leguminous ley is unlikely to be followed by significantly greater yields. In that State it has been estimated that 20%, and in some districts as much as 40%, of the wheat planted is on subterranean clover ley and whereas the grain acreage has remained relatively constant, the area under fallow has declined by 1 million acres, or over 30%.

In South Australia the risk of wind erosion during the bare fallow year has favoured the use of barley rather than wheat in districts where the hazard is greatest. Barley competes better with weeds than does wheat and usually gives relatively higher yields under non-fallow conditions. Moreover, barley cannot be as closely or as cleanly threshed as wheat, so that the self-sown crop in the following autumn provides excellent grazing.

Where the practice of winter fallowing is retained, the land receives fewer workings and sheep rather than cultivation is the means by which weeds are kept under control.

Mechanisation

The trend towards the elimination of fallow has meant that the preparation of the seed bed and the actual planting is restricted to a few weeks or even days instead of months. This has been made practicable by the use of bigger and faster tractors and improved tillage implements, while the larger seed and fertiliser boxes on the seeding-combines enable increased acreages to be sown between stops. The improved tillage and seeding equipment has been matched by a greater use of hydraulic controls on harvesting machinery. The mounting of these machines on pneumatic tyres enables them to be drawn at six or so miles per hour and portable bulk bins and other techniques for handling the grain rapidly have been developed.

The trend towards push-button farming has produced the overall effect that most of the labour force is no longer on the wheat farm, but is located in implement factories, engineering shops, oil refineries etc. In consequence total farm worker income now amounts to only about 10% of the national wage bill in Australia.

Wheat marketing

Although recent years have seen record yields per acre and near record total yields, the steady increase in the carry-over of grain has not only taxed storage facilities, but has resulted in the methods by which the grain is sold in overseas markets being subjected to careful scrutiny.

Australian wheat is sold on a sample basis, the shipment having to be equal to the F.A.Q. standard fixed for the particular State in that season. The F.A.Q. is the weighted average of the millable grain delivered for sale by farmers in that particular season and is defined entirely on the basis of milling value. No attention is given to the baking characteristics of the grain, which varies greatly between districts and even between paddocks on the same farm.

As the principal exporter of wheat in the sterling area, it is considered by many that Australia should be able to supplement Canada as a source of strong hard wheat. When grain of this type has been available from Queensland it has sold readily, and usually at a premium over the ordinary F.A.Q. standard.

The influence of environment and heredity on grain properties

The baking quality of a sample is believed to depend principally on the *quantity* and the *quality* of its protein fraction. The percentage of protein is largely determined by environmental factors, while the quality of the protein is much more varietal, or genetic, in character. Although climatic conditions, particularly temperature and moisture supply during the ripening period, have long been considered the major factors influencing protein content, it is becoming more apparent, from Australian investigations, that they are principally important because of their influence on the availability and utilisation of the soil nitrogen. The nitrogen content of the plant is often at its maximum at flowering time and much of this is rapidly translocated to the developing grain. Rapid ripening will thus minimise the period available for post-flowering synthesis of carbohydrate and result in a high protein percentage. The production of high-protein wheats, for this reason, is for the most part located in areas where ripening is relatively rapid.

Yield and grain protein

The farmer can achieve a higher level of grain protein either by growing his crop on soil which has been under leguminous pasture for some years and is consequently rich in available nitrogen or he can grow varieties with the appropriate genetic constitution. The cultivation of inherently high-protein wheats has been the general recommendation to Australian farmers, but their use is likely to be accompanied by a lowered yield per acre if any great increase is to be achieved by this means. An increase of up to 10% can be anticipated without any depreciation in yield.[3] At the current level of the F.A.Q. this means an overall increase of up to 1% in grain protein, but the general level would remain below the 11–12% demanded by overseas purchasers.

Recent research[4] in Australia has shown that when a starchy low-protein variety is crossed with a translucent-grained high-protein strain the crossbreds behave differently in respect to the association of yield and grain protein, depending on the parental type to which they conform. Among the translucent-grained crossbreds there is a negative correlation between yield and grain protein, but this relationship does not hold for the starchy types. These data suggest that breeding for high protein is more likely to be successful with soft than with hard wheats.

The introduction of ley farming has made it desirable to carry out the seeding operations in a minimum of time and often on somewhat trashy seed beds. This photograph shows a 36-run stump-jump disk drill recently developed by a local manufacturer

Numerous data are now available in Australia which show that an increase in soil nitrogen, by means of leguminous pasture, can result in both increased yield and often in a higher grain protein. At Longerenong, in the important wheat-growing Wimmera district of Victoria, each increment of 0.01% in the total soil nitrogen increased the grain protein by approximately 1%.[5] This relationship was found to apply generally through the Wimmera; but at Rutherglen, in north-eastern Victoria, a relatively smaller increment in grain protein was obtained.

Protein quality

Increments in protein content must be related to variety if they are to have significance in terms of baking quality. Increases in protein content from 6.7% to 14.3% in the variety Gluyas Early produced no significant increase in flour strength, whereas with the variety Bencubbin there was a gain of 0.8 units of strength (as measured on the Farinograph) for each percentage increase in protein.[6] The varieties Gabo and Scimitar gave increments of 1.20 and 1.26 units respectively. By and large, the greater the increase in strength per unit of protein, the better the inherent quality of the protein. A flour protein level of about 9–10% appears to be critical, since the stronger varieties have undesirable baking characteristics at low levels of protein.[7]

The policy of most wheat breeders in Australia during the last two decades has been to select first for baking quality, as measured by a test such as the Pelshenke, and then to test the stronger crossbreds for yield. This policy appears to be yielding satisfactory results in Victoria.

TABLE 1

VICTORIA: TRENDS IN PROTEIN QUALITY OF F.A.Q.

(Means of five-year periods expressed as Pelshenke time/crude protein)

1936–40	1941–45	1946–50	1951–55
2.8	3.2	3.5	4.6

The present position in Australia appears to be that increases in strength figure per unit of protein have been achieved and in several instances, notably Javelin and Kondut, without recourse to hard or semi-hard varieties. Further improvements in protein quality will enable any general increase in protein content resulting from improved rotations to give the maximum overall improvement in baking quality.

The inheritance of protein quality

The recognised strong wheats of the world are hard wheats with horny translucent grain. Some investigators, notably Biffen and Engledow, have assumed that translucency is synony-

mous with good baking quality. In studies of segregating crossbred populations made in Australia it has been found that the translucent-grained segregates have significantly higher Pelshenke times and hence superior baking quality.[8] This is not due to their having a higher protein content, and consequently it would appear that the gene for translucency, which behaves as a simple dominant, is either linked with a major gene for protein quality or is itself directly concerned.

Investigations with very different parental varieties have shown that when the effect of protein is eliminated the yield of translucent-grained types is inversely related to baking quality, as measured by Pelshenke time. Among the starchy crossbreds there was no correlation between yield and Pelshenke time and the genes, for poor baking quality appeared to be dominant. These research data point to the need for a new approach to breeding for improved baking quality, based on a better knowledge of at least the major genes involved. The need for this is emphasised by the results of trials in Canada,[9] which showed that several important Australian varieties were practically equal to Marquis and Thatcher in yield, grain protein and baking quality, as measured by loaf volume.

It is likely that as new knowledge and techniques become available the present F.A.Q. system of wheat marketing will be modified to enable Australia to compete in markets that require particular types of wheat. Varieties bred specifically for biscuit-making and grown in the appropriate districts would then enable Australia to compete for that market as well as in those demanding hard, high-protein grain.

Pasture improvement

It cannot be over-emphasised that the shift to greater livestock numbers on wheat farms, the elimination of fallowing and the raising of grain protein depend for their success on the pasture growth obtained in the years between the cereal crops.

As Sir George Stapledon has said: ' We talk of grass and grassland, but no grassland is worthy of the name unless a legume is at work. Make the conditions suitable for the legume and manage the sward to favour the legume as well as to feed the animal and everything else will be easy—the battle will be won '.[10]

The search for more productive legumes and the conditions that will favour their growth has become a major concern not only of Australian wheat farmers, but also of the research and extension organisations associated with them. On the wetter margins of the wheat belt, the battle appears to have been won, for in these regions subterranean clover (*T. subterraneum*) or barrel medic (*M. tribuloides* var. *truncatula*) form the basis of efficient systems of ley farming. Wheat yields after sub-clover leys in these areas have been doubled and even trebled and sheep numbers and wool yield per sheep increased by from 50–100%. As McLennan[11] has pointed out in a survey of the movements in wheat acreage in Australia, the trends are to reduce sharply acreages in the regions where a quick change over to improved pastures can be safely achieved and to increase them in regions where the scope for economic pasture improvement is very restricted.

The demand is for legumes that will achieve, in the drier portions of the wheat belt, the results that have come in the more favoured rainfall regions.

Mediterranean - type legumes are generally believed to be the most promising for the Australian wheat belt and improved production can come from better management and from superior strains. The scope for improved management of legume pastures is very great and much experience favours over-grazing during the winter to reduce competition in the spring by grasses, such as barley grass (*H. murinum*) and its brome grass counterparts (*B. rubens*, *B. madritensis* etc.), and herbs, such as capeweed (*Cryptostemma calendulaceum*). Heavy dressings of phosphate and, in some areas, appropriate trace elements are required for pasture legumes. Since production fluctuates violently from season to season, the mower is likely to become the most effective agent in pasture management. The farmer cannot carry

A heavy-yielding crop of Pinnacle wheat on ' black ' land in the Victorian Wimmera (Longerenong Agricultural College). Grown on a three-course rotation of pasture (including ' natural ' medics) fallow-wheat, 98 acres averaged 64.3 bushels per acre

sufficient sheep to achieve satisfactory management in the flush years, which are often the most critical, and it is then that the mower is essential. Moreover, it has been shown that paddocks which are mown but receive no other treatment have better summer carrying capacity.[12] This is particularly the case where grass dominance prevails, since the hay is lower in fibre and the nutrients are more uniformly distributed through the plant and not concentrated in the seed. The mowing and subsequent over-grazing of the aftermath of grasses, such as Wimmera ryegrass, a strain which developed in the Wimmera of Victoria, greatly facilitates their control in the following year, when wheat is to be sown on ley without fallow. Clipping and grazing are believed also to favour seed production in sub-clover. There can be little doubt that the future of pastures in the Australian wheat belt rests heavily on the intelligent use of the mower as a means of influencing botanical composition and eking out inadequate spring rainfall.

New strains of legumes

Although much can be achieved by improved management, it will give best results when it is used on superior strains. Where new strains or species are to be introduced, effective nodulation is the first problem that must be solved. Much research has been given to the factors affecting nodulation and has stressed the importance of using, in problem areas, effective strains of nodule bacteria, basic superphosphate and on lighter soils seeding sub-clover at 1–1½ in. deep.

New strains of pasture legumes can be obtained either by direct introduction from the Mediterranean region, by selection from material which was introduced accidentally and has become established, or by artificial cross-breeding and selection.

All the legume strains that are available to the farmer in commercial quantities today have been obtained from ecotypes that have developed fortuitously within Australia, but the alternative sources are being actively exploited.

Collections of indigenous plants were made in the Mediterranean basin by officers of the Australian Commonwealth Scientific and Industrial Research Organisation in 1951 and 1954. These introductions have been supplemented by those obtained through correspondence, and there is today a large amount of material under trial, either for direct use as strains or for breeding purposes. In addition to actual production, factors such as palatability are important. Under the extensive system of grazing practised on most Australian wheat farms there is much in favour of a legume which is not over-palatable.

The two loaves on the left were baked from wheat grown on regularly cropped land. The two loaves, with superior loaf volume, on the right were produced from wheat grown on land that grew subterranean clover pasture for four years prior to cropping. Both crops were grown on fallow in adjacent paddocks, on similar soils, at the State Research Farm, Werribee, Victoria

Early-maturing strains are essential for the drier portions of the wheat belt, since species which remain green after the barley grass has died off are subjected to intensive selective grazing. Earliness is usually associated with stemminess and breeders are endeavouring to modify this linkage. Genetic means for achieving a considerable improvement appear to be available for subterranean clover.[13]

While the winters of the major Australian wheat belts are relatively mild, pasture growth is, nevertheless, often inadequate for pasturage of the normal complement of sheep being carried by the farmers and the lambs dropped in the autumn. While cereals are favoured, at present, to give winter growth, the possibilities of improving the winter production of pasture legumes is a major objective of breeding programmes.

In an annual the seed is the bridge between generations and represents a valuable reserve for the dry summer months. Selection to improve seed production is therefore being undertaken.

While the battle for better legumes is far from won, considerable progress has been made, and though a real assessment of the position is difficult because of the abnormally favourable seasons experienced in recent years, results are at least encouraging. A vigorous winter-growing legume is the answer to many weed problems as well as the key to more successful ley farming.

The pressure from farmers for new knowledge to minimise the risks from the adoption of new practices has been very great. Surveys have shown the high ranking that they give to pasture improvement and in one State a voluntary levy to support pasture and associated research has been supported by 85% of wheat farmers. The recent establishment of an agricultural research institute at Wagga Wagga in New South Wales will add greatly to the facilities already available.

While the likely developments in respect to pasture species have great significance for the Australian wheat farmer, it may well be that, as has been the case with wheat varieties, they will prove of direct value also to the farmers elsewhere in the world where similar climates prevail.

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English Grass Wins World Championship

In spite of difficult harvest conditions, British seed growers and merchants have again achieved outstanding results at the Royal Show of Canada. For the first time ever an English-grown sample of S.37 British National Certified Cocksfoot grass seed has won the world's championship at the Royal Agricultural Winter Fair, 1956, Toronto. This forage crop seed, grown by Mr. A. Robertson, of Minster, Kent, on contract for Hurst and Son, of London, represents a resounding victory for British seed growers in winning this much coveted award against world competition.

HERBAGE LEGUME RESEARCH AT ABERYSTWYTH

W. ELLIS DAVIES, B.Sc.

(*Welsh Plant Breeding Station, Aberystwyth*)

In this article the author gives an account of recent progress in herbage research at Aberystwyth. The three legumes, lucerne (Medicago sativa), *red clover* (Trifolium pratense) *and white clover* (Trifolium repens), *have been under study at the Welsh Plant Breeding Station since* 1920, *during which time a considerable body of information has been gathered concerning the biology, genetics and agronomy of these species. In addition, two strains of each of the clovers have been released for marketing, S.*100 *white clover being the better known. Other species have from time to time come under observation,* e.g. *sainfoin* (Onobrychis sativa), *bird's foot trefoil* (Lotus corniculatus), *kidney vetch* (Anthyllis vulneraria), *and so far these are of minor importance, but strawberry clover* (Trifolium fragiferum) *continues to receive attention.*

WHITE clover is the most widely used legume under British conditions and is nearly always included in all but very short-term mixtures. For one-year leys, red clover often takes pride of place as the major constituent, but it is also used in longer leys both for hay and grazing. The area of lucerne grown in England and Wales is not much more than 100,000 acres, but the opinion has been expressed that this acreage should be considerably increased. No other crop will provide as much dry matter and crude protein over a number of years and during periods of midsummer drought. In the absence of a legume, and without additional nitrogen, production from a stand of grass would hardly reach half a ton of dry matter per acre, and this would contain the 20–50 lb. of nitrogen obtained from the soil each year. A good crop of lucerne, on the other hand, under the same conditions will produce 4–5 tons of dry matter, containing about 300 lb. of nitrogen, mostly obtained from the nitrogen in the air.

Breeding problems

The breeding of improved herbage plants presents many unique problems because of the innumerable demands made on a new strain and also of the absence of completely satisfactory techniques for the measurement of progress. This complexity varies from species to species and the three legumes included in the programme illustrate this point. Lucerne is a plant that is often sown as a pure crop from which the produce is cut for silage or dried grass. In this instance a simple cutting technique can legitimately be used to collect yield data from the experimental plots, and figures for dry matter and protein content calculated. The complicating effect of companion species, as well as the grazing animal, can be virtually ignored. On the other hand, when white clover is under study it must always be borne in mind that this species is almost invariably sown with a companion grass and the produce periodically grazed. These factors must be taken into consideration in developing an adequate technique for the assessment of productivity, but as yet no short-cut method has been evolved to test the large number of selections necessary in a breeding programme. Red clover will fit into either category, as the one-year ley utilisation resembles that of lucerne, while the use of late-flowering types would correspond to that of white clover.

The seasonal spread of production is another factor of even greater importance than total annual yield and this has to be maintained over many years. Management can also profoundly affect performance during the year and its effects may be carried forward into following seasons.

Fertility relationships in these legumes do not lend themselves for easy exploitation; it is perhaps not surprising, therefore, that Watkin Williams[1] was able to write ' that it has been difficult in many cases to show statistically significant (agronomic) differences between the natural ecotype and bred strains '. This is a problem that has been under careful study during recent years; some of the results of these investigations will be discussed here.

The ultimate unit

The plant breeder ultimately deals with single plants, but how much reliance should be placed on their performance is open to question. A large amount of detailed information can be obtained by single plant studies in respect of characteristics, such as growth habit, emergence and flowering dates, tillering capacity and disease reaction, but other important traits, *e.g.* yield, rapidity of establishment and inter- and intra-specific competitive ability, generally cannot be assessed by this means. In order to get further data on this problem, and to relate the behaviour of single plants to their performance in mixtures, four strains of lucerne were grown in one experiment as spaced plants, in drills 2 ft. apart,

Fig. 1. Layout of selection technique experiment. The left half of the photograph shows alternate lucerne/grass drills 1 ft. apart, beyond which are lucerne drills 2 ft. apart and broadcast lucerne plots. To the right are single plants and, beyond them, broadcast lucerne/grass plots

in broadcast plots, with a companion grass in broadcast plots, and alternate lucerne/grass drills (see Fig. 1). The conditions here range from the single plant, where each has the maximum space to develop in the absence of both inter- and intra-specific competition, to the plot broadcast with a grass companion, where there is intensive competition at the inter- and intra-specific level.

A first analysis of the data showed that all the strains did not give the same relative result under all treatments and a further breakdown showed the main discrepancies. If the broadcast plot was taken as control, then the single plant data were the least satisfactory as far as strain yield was concerned. In particular, Provence lucerne performed very poorly as single plants, but was relatively much better under drill and plot conditions. The S.205 lucerne consisted of very attractive high-tillering, bushy and leafy plants compared with those of Du Puits, which were tall, stemmy and had relatively fewer tillers, and on this basis the former could be deemed to be the more desirable. In the broadcast plots, however, there was little doubt that Du Puits was the better strain, as the stemminess and coarseness were now not apparent. In fact, Du Puits was outstanding in its performance under all conditions.

The lessons to be learnt from this experiment are that good single plants do not necessarily mean equally good sward results and that the converse also appears to be true. There are also plants which have a wide range of adaptability to environmental requirements, and these always repay selection. The necessity for the practical plant breeder to be a competent agronomist, as Sir George Stapledon has often repeated, is further emphasised. This is particularly the case in dealing with a crop like lucerne, which is not very widely grown and about the agronomy of which there is still a lot to learn. It is only after a thorough study of the behaviour of plants under different conditions and circumstances that desirable characters become clear, so that eventual selection is made on fact and not on a hypothetical type conjured up in the breeder's mind.

Lucerne agronomy

A few facts of agronomic significance were also noted and are shown in Table 1.

The companion grass was S.215 meadow fescue (*Festuca pratensis*), sown at the rate of 3 lb. per acre; over the two years, the mixtures gave a higher yield than the corresponding lucerne-only plots. The yield from the drills was much less than that from the broadcast plots, indicating that even when drills are spaced 1 ft. apart the best use was not made of the available space. Single plants made still poorer use of their space, giving only half the yield of the broadcast plots. Under conditions of the drought experienced in 1955, however, the single plants showed to advantage in comparison with the broadcast plots. The available water was insufficient for the plots and the plants wilted, while the singles remained green and continued to grow. The percentage crude protein was higher in the grass from the broadcast plots than in that from the drills, but this was partly due to a higher proportion of grass to lucerne in the drills.

Differences were also observed in the strain comparisons, with a distinct tendency for the grass growing with Du Puits and Provence to have a higher percentage of crude protein than that associated with Grimm and S.205. There were also differential competitive effects between strains of lucerne

TABLE 1

TOTAL YIELDS OF LUCERNE AND LUCERNE/GRASS: CRUDE PROTEIN AND PERCENTAGE WEEDS UNDER DIFFERENT TREATMENTS

Mean of four strains for two harvest years (Rausch)[2]

	Lucerne, broadcast	*Lucerne + grass, broadcast*	*Lucerne + grass, alternate drills 1 ft. apart*	*Lucerne, drills 2 ft. apart*	*Lucerne, single plants 2 ft. × 1 ft. 6 in.*	*L.S.D.,* 5%*
Total yield (lb. per acre)	6,870	7,479	6,057	4,683	3,459	411
Total yield relative	100	109	88	68	50	—
Lucerne-only yield (lb. per acre) ..	6,417	5,367	3,726	4,683	3,459	498
Lucerne-only relative	100	84	58	73	54	—
Crude protein percentage—grass only	—	13.3	10.9	—	—	—
Percentage weeds	12.7	5.4	—	—	—	—

* L.S.D. = Least significant difference—5% level.

and grass broadcast and sown in drills, as shown by the following figures:

	Yield of grass, lb. per acre From	
	Alternate drills	*Broadcast plots*
Du Puits	728	455
Provence	776	540
Grimm	789	892
S.205	812	766
L.S.D. 5%	Not significant	165

At 1-ft. spacing, lucerne strain had no effect on the yield of companion grass, but in the broadcast plots the lack of aggressiveness of Grimm and S.205 was very evident (see Fig. 2). This is an important agronomic character which is only seen in the broadcast plots. It appears to be linked with poorer initial establishment, a shorter growing season and slower recovery after cutting, as all these characteristics allow the companion species to grow more freely. This tends to make the late highly tillering types of lucerne less persistent than would be expected from analogy with some grass species.

The addition of nitrogen encourages the grass fraction of a grass/legume mixture and this increased competition from a companion grass can have a deleterious effect on the legume. This is so in the case of Grimm lucerne, where the addition of 7 cwt. of sulphate of ammonia doubled the percentage of grass in a mixture from 30 to 60%. With Du Puits, on the other hand, doubling the grass contribution only increased it to about 20%, and by the second harvest year even this amount of grass was practically eliminated. There was no economic advantage to be obtained from applying 7 cwt. of sulphate of ammonia to Du Puits alone or when in a mixture with grass. In the Grimm mixtures application of nitrogen had further encouraged the grass fraction and gave an overall increased yield of 14 cwt. dry matter per annum. Since this result was obtained by unbalancing the mixture, it is of rather doubtful economic importance.

It has been said earlier that a simple cutting technique can be adopted to obtain yield data from lucerne strains, but time of cutting can have a profound effect on yield in that and in following seasons (see Fig. 3). From an operational point of view it is preferable, having decided on the optimum number of cuts, to harvest all strains on the same date, irrespective of stage of development. Where variety tests are conducted at centres some distance from headquarters it may be a practical impossibility to make the necessary number of visits to cut at the same stage of development. The final analyses might also be complicated by differences in weather conditions at the time of cutting, as well as by the number of cuts taken and the date of the last cutting.

It is important, however, to have some idea of the consequences of cutting at different times and an experiment was recently set up for this purpose. Eight strains representing early, mid-season and late types were used and three cutting treatments superimposed. These treatments and the results for two strains are shown below.

Treatment	*Yield of dry matter, lb. per acre*	
	Du Puits	*Rhizoma*
Cut four times at fixed dates	5,105	3,827
Cut three times at fixed dates	6,373	5,453
Cut twice at same stage of development	6,210	7,783

Under the four-cut system the yield of Rhizoma was seventh out of eight. It gave the highest yield of all under twice-cutting. Du Puits, on the other hand, gave a relatively high yield under the three systems, being in first, second and second positions. This again illustrates the adaptable nature of a particular strain compared with another whose requirements are much more precise.

Previous experimental work at the Station has shown that the optimum number of cuts for lucerne is three and this procedure is now followed as a regular routine. Weather conditions in a particular year may, however, have an overriding effect and this was found to be so in 1954, when the rainfall totalled 52 in., as against a 30-year average of 42 in., with a corresponding reduction in sunshine hours. Cutting lucerne three times during the first and second harvest year (1954) had a disastrous effect on the stand, but where only two cuts were obtained a full stand was carried through to the following season.

During 1955 the rainfall was only 33 in., so that conditions were again exceptional, and, although stands on shallow soil suffered severely from drought and other related limiting factors, there was apparently little effect on the surviving crop in the following year. Seasonal variations of this magnitude can be a hindrance to progress, until methods for making allowances for them are brought into current practice.

White clover

White clover needs a rather different technique from the cutting treatments outlined for lucerne. One of the limiting factors, however, is the small amount of seed available in the early stages of breeding and the large number of progenies to be tested. Clones of selected plants are polycrossed in an isolation island in the open, or in a

Fig. 2. Cutting lucerne/grass plots after removing borders. The foreground shows a Grimm/S.51 timothy mixture, in which the high proportion of grass can be seen

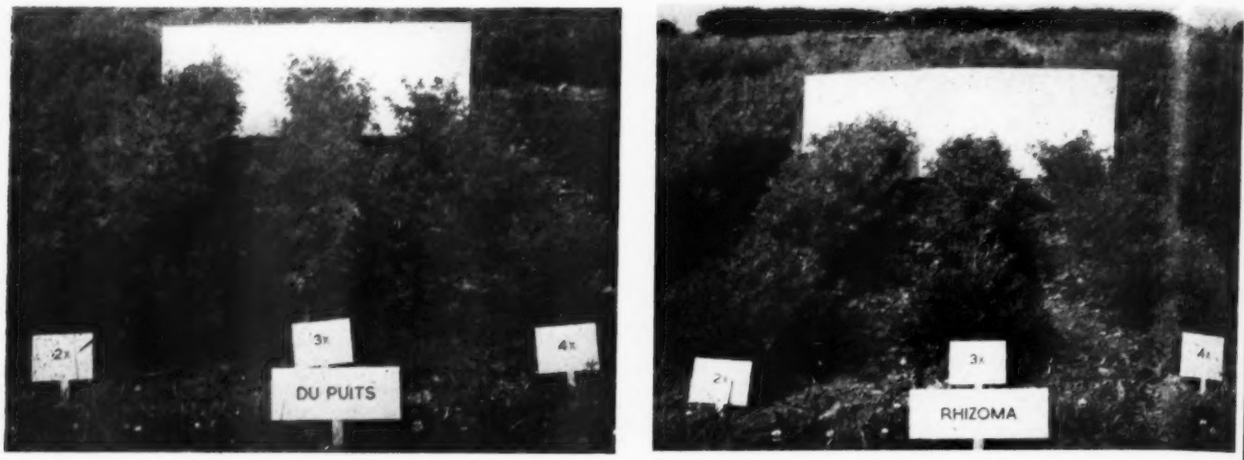

Fig. 3. Residual effect of two, three and four cuts respectively (marked 2x, 3x, 4x) in the previous year. The photographs were taken after one uniform cut in 1955. (Left) *Du Puits.* (Right) *Rhizoma*

greenhouse, when a small colony of honey bees or bumble bees is introduced to effect pollination. The progenies of these polycrossed plants have usually been grown as single plants, but in 1956 the seedlings were planted 1 ft. apart in a plot 9 ft. × 9 ft. The whole plot was then oversown with S.24 perennial ryegrass to establish a sward and this was achieved very soon. Two rows of timothy grass were drilled 1 ft. apart between each plot to facilitate the removal of any stolons of white clover that encroached between the rows, thus restricting the clover to the plot where it was planted. The first cut was harvested when the sward was 6 in. high and the regrowth sampled and grazed off by sheep. Each plot was grazed individually, using two sheep in a portable fold 10 ft. × 10 ft., made of light aluminium alloy of a type now being used in the Grassland Agronomy Section. There are a number of practical problems to be overcome in using such small plots, as there is a tendency for the sheep to overgraze around the edges, while patches in the centre are soiled and left ungrazed. As the same selections have also been established as widely spaced single plants in an adjacent area, it is hoped to be able to correlate the behaviour of these and the swards. Although all the important establishment data cannot be obtained in this way, it is expected that a clear picture of competitive effects of clover/grass will emerge.

Number of basic plants

Another problem in strain breeding is the appropriate number of basic plants to use as a foundation for the strain. In cross-breeding crops where inbreeding has immediate deleterious effects on yield it has been the practice to use a fairly large number to avoid this inbreeding depression. Some data on this question have been collected from an experiment with red clover started in 1945 by Watkin Williams.[3] A total of 15 synthetic strains was built up from various combinations of three, six and 12 plants selected at random, while 200 unselected plants from the same population of Montgomery red clover acted as control. These 16 strains were multiplied to the fifth generation and all the second to the fifth generations of the 16 strains were planted in the field in 1950. There was a significant reduction in yield from the second to the fifth generation, but this occurred mainly in the strains based on three plants. In the second generation some of these three-plant strains showed considerable evidence of hybrid vigour, giving a single-plant yield of as much as 50% above control, but by the succeeding generation this extra vigour had been dissipated. Where more than three plants were incorporated into the base of the strain, either from within the same families or from unrelated families, there was a tendency for the performance to be nearer to that of the control strain. It is emphasised that in this experiment there was no conscious selection, so that the extra vigour observed arose from random crossing.

From this experiment it would appear that it was quite safe to reduce the basic number of plants to six with a strong suspicion that this number could be further reduced to four or even less, provided the right combinations of plants were found. Six appeared satisfactory where no selection occurred, so that one would expect even better results where selection was operating. This result was obtained with diploid plants ($2n = 14$), but the number would probably be different in polyploid plants with other chromosome numbers.

At the present time it is not clear how the considerable amount of heterosis manifested in the second generation can be economically exploited. It is possible by vegetative propagation to produce sizable areas of propagants, but the relatively slow rate of multiplication of red clover from seed militates against the success of a scheme similar to that used for double-cross hybrid maize. It is certain that yield increases would have to be substantial to make the project feasible.

The progress described has been mainly concerned with techniques of strain production. Attention is devoted to resistance to clover rot (*Sclerotinia trifoliorum*) in red clover and some of the common lucerne diseases, leaf spot (*Pseudopeziza medicaginis*) and black stem (*Aschochyta imperfecta*) are under study. Chromosome numbers of the three legumes, lucerne, white and red clover, have been doubled and the potentiality of the plants as breeding material is being explored.

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RICE GROWING IN AUSTRALIA'S NORTHERN TERRITORY

An ambitious scheme for land reclamation and settlement

L. T. SARDONE

Australia is geologically one of the oldest countries in the world and the virgin soil, now being prepared in the Northern Territory for the cultivation of rice, is shallow, hard and intractable. The Humpty Doo project is of immense significance and importance to countries with similar conditions.

ON a 100-mile front, lying parallel with the coast east of Darwin, chief town of Australia's Northern Territory, one of the world's leading rice specialists and a team of 50 men are fighting a battle. Their battle is with rock-like soil and if successful it will mean millions of pounds of additional income to Australia every year.

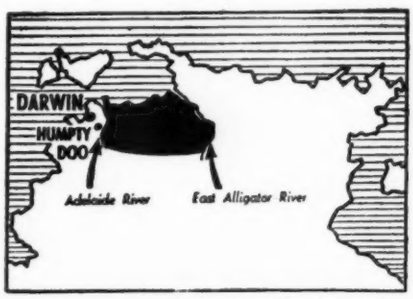
The team is methodically breaking up, ploughing and cultivating lands which since Creation have never known a plough. Their objective is to harness 750,000 acres of once-barren land for growing rice and a variety of legumes and beans which can be used for cattle fodder and the manufacture of linseed oil.

The rice specialist is an American agronomist, Arthur Hofman, who has tamed Venezuelan jungle and Mexican desert. He has just completed the first stage of the biggest land-reclamation job of his career—at Humpty Doo, 37 miles south-east of Darwin, and has this to say about the scheme: ' So far we have only been scraping the surface with the cultivation of the initial 250 acres. This may appear very little in view of our 750,000-acre target, but our first job is to find a rice that is really suited to Darwin conditions. When that is done—and the success of the harvest recently shows we have made a pretty good start—we can start planting much larger quantities '.

An American-Australian company, Territory Rice Ltd., with a nominal capital of £A5 million, of which one-third is Australian, is promoting the scheme. It has taken out a lease of the area from the Australian Commonwealth Government and has agreed to cultivate 500,000 acres within the next 15 years.

The Government showed the warmth of its interest right from the beginning by establishing an experimental rice farm at a place called Sixty-Mile, 40 miles south-west of Humpty Doo. Australia, in her rice-growing States, last year produced 92,000 tons of rice, two-thirds of which was exported; if the company's plan is successful, Australia will be producing more than 500,000 tons of top-quality rice annually. Nearly all of the rice to be grown at Darwin will be exported to the islands and countries lying to the north of Australia and this will help foster goodwill with her Asian neighbours.

The employment of up-to-date mechanised equipment will lower labour costs sufficiently to enable Australian rice to be sold in competition with rice grown in cheap-labour areas. Still, even with mechanisation the scheme will offer thousands of new jobs for people in the Territory.



Scene of operations in the Northern Territory of Australia

Close-up of rice heads

The project

Its pioneers see the birth of a new era for the Territory when the scheme, which began in November 1955 with the planting of the first 250 acres of rice, really gets under way. In the narrow sub-coastal belt, farms and small communities will spring up where once only the buffalo and the nomadic Arnhem Land aborigines roamed. New local industries, such as rice milling to process the home-grown crop, will win more people into the district. Special areas for fattening cattle will also be set aside to make use of the locally produced fodder.

In the winter months of 1956 (June–September) men were in the field surveying a further 20,000 acres for planting when the monsoons begin again at year-end. Without the monsoonal climate of the Territory it would have been impossible to attempt the project at all. However, where there is heat and water for long enough during the year productivity of almost any terrain can be restored. The monsoons transform the rock-like soil into a swamp

Automatic gun, used for scaring birds

which it is possible to drain sufficiently to plough and plant rice.

The rice roots grow straight down into the muddy soil and help to break it up into small particles after it has been torn open with ploughs, bull-dozers and harrows.

After harvesting—at the end of the monsoon—the soil dries up again and the rice stubble is ploughed back into it. This lets the sun and air into the soil and gives it vitality, so preventing leaching or the draining away of mineral elements needed by the crops. As each year passes, the soil becomes more and more productive.

The main problem

The real problem, Mr. Hofman stresses, is to restore the fertility of the earth to a depth at which not only rice, but any crop suitable to the climatic conditions, could be grown. Roots of the desert grasses which normally grow in the district spread out flatly just under the surface of the soil and rarely go more than 2 in. deep. Even in the monsoon season the soil is so hard that the water softens the soil only to a depth of about 8 in. The rice roots would aid the land reclaimers' task, as these roots would penetrate a further 6 in. into the rock-like soil.

Australia is one of the oldest countries in the world yet the land being worked on has never been touched previously by mortal hand. It can be muddy one day and within a few hours so hard that the toughest plough will not penetrate it. None of the practices hitherto used by Mr. Hofman could apply, and he had to work out new methods as he went along.

Rice varieties

Even so, one head of the variety, Madang White, which was planted produced 687 grains, well above the average yield of 500, and possibly a world record. The overall yield was more than 1 ton per acre. One acre yielded 2 tons, which was most encouraging.

Varieties under experiment at the moment include: Blue Bonnet, Caloro, Gopher Short, Madang White, Mekeo, Meli, Magnolia, Oentong, Rexoro, Radin, Siak and Tribulation.

Overall picture

The 320 acres which have been planted experimentally at Humpty Doo for three consecutive years are being harvested at the time of writing. Since April they have yielded 200 tons of top-grade rice, largely predominated by the long-grained Blue Bonnet, possibly the finest of its kind in the world. By the time harvesting is completed Territory rice will almost certainly have 50 tons more grain than it needs for planting. Arrangements are in hand for this surplus to be sold locally.

Meanwhile, a carefully scientific 'staggering' in the 1955 planting is enabling the rice men to harvest progressively over a period of seven weeks, while at the same time they go ahead with ploughing for the 1956 planting.

A big new drying machine is preparing the newly gathered grain for the next sowing and for the first local sales. There will be a big increase in sowing activities as the project is swung into its first serious commercial phase after the three experimental seasons.

Ploughing has also started at a virgin 1,000-acre paddock on the Adelaide River plains, about eight miles north of the Humpty Doo headquarters. The harvest during April, May and June of 1957 is being planned to yield many thousands of tons of the several varieties from locally grown seed, as above. The 1957 planting for the 1958 harvest is expected to total at least 5,000 acres, with a minimum yield of 10,000 top-grade tons.

A field of rice, ready for harvesting

Advance Australia!

Research is Australia's greatest investment

Australia is the largest island and the smallest continent in the world. At the beginning of the 17th century her total population consisted of a few thousand aborigines; today there is a population of over 9 millions and as a result of research it is considered that it will one day be able to support a population of some 25 million people.

DURING the 16th century there was a belief in the existence of a great southern continent, a *Terra Australis Incognito*, which, according to the ideas of those days, must exist to balance the land masses of the Old World. Following the voyages of the first Portuguese and Dutch navigators in 1606, the Dutch ship *Duyfken* sailed along the west coast of Cape York peninsula, and in 1616 Dirk Hartog, a Dutch navigator, visited part of the west coast of the continent. In 1642 Tasman discovered Tasmania and New Zealand. Dampier, an Englishman, visited the north-west coast in 1688, and in 1770 Captain James Cook explored and took possession of the east coast.

The six Colonies (which became States when Australia became a Federation in 1901) were created as follows: New South Wales in 1788, Tasmania in 1825, Western Australia in 1829, South Australia in 1834, Victoria in 1851, and Queensland in 1859. The Commonwealth Constitution Act was passed by Parliament in the U.K. in July 1900 and the first Federal Parliament was opened in Melbourne in May 1901. Parliament was moved to Canberra in May 1927 and today this is still the Federal capital.

A proud democracy

Australia is proud of its democratic traditions, especially as it has been a pioneer in such fields as the secret ballot for voting at elections, compulsory voting and women's suffrage. The system of government in both Commonwealth and individual States is modelled on the British Cabinet system.

Australia is a self-governing nation within the British Commonwealth of Nations. The only constitutional link is the Crown, but there are also strong bonds of friendship and unity of ideals and purposes with Britain and the other constituent members of the Commonwealth of Nations.

The Colombo Plan

Following goodwill visits to Ceylon, Pakistan and India by the Australian Minister for External Affairs, a British Commonwealth Consultative Committee met in Sydney in May 1950 to evolve a workable plan of economic and technical assistance to the countries of South and South-East Asia. This was carried a step further in London and in October 1950 it resulted in the Colombo Plan for Co-operative Economic Development in South and South-East Asia. The Australian Government decided to contribute £31 million over a six-year period towards the economic development section of the plan, and up to £3½ million for technical assistance. This technical assistance is being given in the form of expert advice and the grant of scholarships for study in Australia by students from participating countries.

Population and extent

Australia is the smallest continent and the largest island in the world. It is nearly 3 million square miles in extent, but about one-third of the continent is too arid to support anyone, and the rainfall in another third is too low to permit close settlement. It is estimated that the population on 31 December, 1955, was 9,313,000. More than 6 million live in cities and towns, including nearly 5 million in the six capital cities. The population distribution, as revealed by the 1954 census, was: metropolitan 53.9%, urban provincial 24.8%, rural 21% and migratory 0.3%.

There are in Australia about 600 thousand square miles of habitable or 'temperate' country, which is about one-third of the temperate area of the U.S.A., and, after allowing for mountainous and inaccessible land, it is considered that, under present plans for improvement, this area could support some 25 million people.

Her climate

In a country the size of Australia it is possible to experience every kind of climate. The west coast of Tasmania has been compared to the west coast of Ireland with its rain and mists. Much of the southern part of Australia has been compared to the Mediterranean basin with its warm summer and long hours of sunshine. In the north approximately one-third of the continent lies within the tropics and, by way of contrast, snow sport can be enjoyed in the Australian Alps for several months during the year.

The hottest area is in the northern part of Western Australia; the coldest is in the south-eastern part of the continent—the region of the Australian Alps—where readings as low as 0° F. are occasionally recorded. The continent is not within the earthquake zone and destructive cyclones are rare.

Inland there is a vast area of desert country, much of it resembling the Sahara. Lakes and rivers marked on the map in this region are no more than dry watercourses, except for a few days following the rare rains. This zone is surrounded by the semi-fertile belt, which with its low rainfall is not suitable for close settlement. The wheat plains and sheep country of the south-east river basin have been compared to the Caspian steppes of Russia; the tropical north of Australia to the monsoon area of Central India, and the heavy rainfall area of the north Queensland coast to the Madras coast of India.

On the Hunter River, New South Wales. Stockmen driving a herd of steers after watering

Water the key

In many low rainfall areas the water supply is augmented by artesian bores, which bring up water from far below the surface. Possibilities are being examined for inland irrigation schemes in these semi-arid regions.

At present over 1½ million acres are irrigated. The largest reservoir is the Hume Dam on the Murray River on the borders of Victoria and New South Wales. It now holds 326 billion gal. of water, which is almost two and a half times the size of Sydney Harbour, which has an area of 21 square miles. It is now being enlarged so as to double its present capacity.

Agricultural production

In spite of her small population, Australia is one of the leading agricultural nations in the world, and her products are a considerable contribution to the food and clothing supplies of many overseas countries.

The range of her pastoral and agricultural industries is very great. She produces 30% of the world's wool and about 60% of its merino wool. Lamb, mutton and skins are also important products of the sheep-raising industry. Cattle provide beef, dairy products and leather, and other livestock raised in great numbers include pigs and poultry.

Australia is one of the principal wheat-exporting countries of the world and she also produces other grain crops. Fruit and horticultural crops of many varieties are grown in every State. Dried, canned and preserved fruit, as well as jams and canned vegetables, are important Australian products, as are honey and powdered and condensed milk.

The actual figures are startling. It is estimated that there are about 131 million sheep, which produced in the 1954–55 season about 1¼ billion* lb. of wool, worth about £350 million; there are about 15 million head of cattle, of which nearly 5 million are dairy cattle, and they produced 191 thousand tons of butter, 45 thousand tons of cheese and 714 thousand tons of meat. Sheep produced 380 thousand tons of mutton and lamb; pigs gave 84 thousand tons of pork. There are, in addition, 803 thousand horses in Australia.

The 1947–48 record wheat harvest totalled 220 million bushels from 14 million acres. In 1954–55, 168 million bushels of wheat were harvested from 10½ million acres; in the same season 33 million bushels of oats were harvested from 2½ million acres and 4 million bushels of rice from 350 thousand acres. Maize, hay and other fodder crops are also grown on a considerable scale. In this same season 479 thousand tons of refined sugar were also produced.

*1 billion = 1,000 millions.

The value of research

One of the principal institutions in Australia is the Commonwealth Scientific and Industrial Research Organisation, which was founded in 1926. It concerns itself with primary and secondary industries, forestry, fisheries and agriculture, has some outstanding achievements to its credit and is regarded as Australia's most profitable investment.

The Minister in charge of the C.S.I.R.O. is the Rt. Hon. R. G. Casey. He has given the total cost of the organisation since its inception as £A33 million and the present annual budget is now about £A5 million. Against this expenditure there are financial benefits arising from its researches, which in a single year greatly exceeds the whole cost of the C.S.I.R.O. over the past 30 years—and these gains will continue on into the future—year after year.

It is not possible to guarantee that every pound invested in C.S.I.R.O. research will give fantastic returns; research by its very nature is a probing in the dark. Nevertheless, a high proportion of the investigations are highly profitable and these more than cover the cost of the remainder.

Research has shown how very greatly it is possible to increase the fertility of soils in adequate rainfall areas; the scientists now believe that there are 300 million acres capable of supporting improved pastures, as against their belief only a few years ago of a maximum of 30 million acres.

Soil fertility

Thus in the Ninety-Mile Plain of South Australia, soils which formerly carried only stunted scrub now produce lush pastures merely as a result of adding a few shillings' worth of copper and zinc salts per acre along with superphosphate. This area would previously carry about one sheep per 10 acres; it now has farms carrying two sheep to each acre, an increase in productivity from 8*s.* to £A7 per acre. In consequence, land values have risen

from £A1 to £A25 per acre, according to the Minister, and the potential increase in productivity from these 2 million acres is estimated to be worth more than £A12 million a year.

Remedying soil deficiencies in the extensive tablelands of New South Wales has resulted in improved pastures and a twofold to threefold increase in productivity. This applies to a total of more than 6 million acres, which are capable of improvement and will result in an increase in the value of production amounting to £A50 million per year.

A pasture established in the 90-mile desert. New life has been given to the land by the use of zinc and copper, applied in trace amounts. The foreground is virgin desert scrub, which has not been treated

Control of pests, diseases and weeds

Myxomatosis, which has so successfully reduced the ravages of the rabbit, was estimated by the Australian Bureau of Agricultural Economics to have resulted in an increase of £A32 million in the value of the 1953–54 wool clippings and the overall increase in primary production was estimated to amount to £A50 million per year—more than enough to pay for the whole cost of C.S.I.R.O. in the 30 years of its existence.

Similar returns have resulted from research in the field of weed control. The most spectacular of these achievements was the elimination of an impenetrable jungle of prickly pear from 60 million acres in northern New South Wales and Queensland and restoring it to agricultural and pastoral production. The Minister estimates that the value of production from this reclaimed land must now be worth at least £A50 million a year.

The pastoral industry has also benefited by the control of various pests and diseases, which formerly involved the industry in heavy losses. For instance, research on the internal parasites of sheep has reduced deaths and increased the quantity and quality of the wool produced. Work in this field, which cost only £A150 thousand, now results in an addition of £A10 million each year to the sheep and wool cheque.

The Riverina of New South Wales. This sheep station, covering 60 sq. miles of undulating parkland, was formerly timbered

Timber research

Research has also enabled Australia to achieve a fair measure of self-sufficiency in its timber requirements. She has a wide variety of timbers, many of which are of considerable value, but they require proper treatment before they can be used to the best advantage, and until research had provided the necessary information to enable this to be done they were largely neglected. Local timbers now meet more than 80% of the Australian demand for timber—a saving of more than £A30 million each year in timber imports. The development of a process for producing paper from the short fibres of eucalyptus timber has resulted in a paper and pulp industry worth £A10 million each year in imports.

Hundreds of millions saved

These are a few of the more spectacular achievements of the C.S.I.R.O. There are similar, if less spectacular, successes in the other fields of work which all add up to a gain of some hundreds of millions of pounds a year. Truly may it be said, then, that well-directed research is Australia's most profitable investment.

Behaviour of Radioactive Contamination in the Ground

C. B. AMPHLETT, B.SC., PH.D.
(Atomic Energy Research Establishment, Harwell)

The spread of radioactivity throughout the soil is governed to a large extent by certain physical and chemical factors. This article examines the role of the soil in limiting the spread of contamination on the basis of known chemical properties of soils.

CONSIDERABLE interest is being shown at the present time in the contamination of the earth's surface by radioactive matter from nuclear test explosions. Similar problems could arise locally to an enhanced extent in the event of nuclear warfare, or as a result of an accident involving a nuclear reactor, or in a crash involving a vehicle propelled by nuclear fuel. Ground could also become contaminated from an accidental discharge of radioactive waste being transported by road or rail, or due to a break in a pipeline carrying radioactive waste solutions. In such cases of local contamination the questions which immediately arise are (*a*) what effect will this have upon the immediate locality, and (*b*) how far and how fast can the contamination spread throughout the ground to other areas?

Contamination of crops and soils

Farmers in particular are much concerned about the effect of the contamination upon their crops and how soon the contaminated ground can be made fit for further use. Radioactivity may be taken up by the roots of plants growing locally and may be passed on to animals or to humans in this way; the pattern in which the different chemical species are taken up by plants of different types (root crops, leaf crops, seed crops etc.) is extremely complex and the overall effect depends in part on which part of the plant is normally eaten. The question of uptake by plants is outside the scope of this article; as regards the other side of the picture, *viz.* the movement of radioactivity through the soil, it is possible to make certain generalisations based on the chemical nature of the radioactive species, the type of soil and certain other features. This article examines the question chiefly from the standpoint of physical and inorganic chemistry.

Firstly, it is important to remember that the radioactive elements which arise in nuclear fission, the fission-products, represent some 30 different species with widely differing chemical properties, so that we would not expect them all to show the same behaviour when absorbed on soil. Secondly, the physical nature of the contaminating matter itself may vary greatly. The simplest case is one in which a radioactive waste solution is accidentally discharged to the ground; here all the chemical species are initially present in the solution as dissolved matter, and as such will penetrate into the soil unless some chemical reaction takes place in the latter which fixes them locally. On the other hand, the products of a nuclear reaction occurring at a very high temperature, *e.g.* a nuclear explosion or a runaway reactor, will ultimately settle on the ground as solid particles of varying sizes in which the radioactive fission products are

TABLE 1
CHARACTERISTICS OF IMPORTANT FISSION PRODUCTS AND THEIR BEHAVIOUR ON SOILS

Fission product	*Half-life*	*Radiation*	*Behaviour on soil*
Caesium-134	2.3 years	β, γ	Absorbed readily on soils having appreciable base-exchange capacity over a wide range of acidity. Not precipitated by alkaline soils.
Caesium-137	30 years	β, γ	
Strontium-89	53 days	β	Absorbed readily on neutral or alkaline soils having appreciable exchange capacity, but absorption is poor under acid conditions. Partly precipitated on highly alkaline soils; precipitated efficiently in presence of phosphate.
Strontium-90*	28 years	β	
Yttrium-91	57 days	β, γ	Absorbed by ion exchange on acid soils having good capacity. Precipitated by alkaline soils.
Cerium-144*	275 days	β, γ	
Promethium-147	approx. 4 years	β	
Samarium-151	122 years	Weak β	
Zirconium-95 Niobium-95	65 days 35 days	γ	Absorbed very readily over a wide range of acidity, due largely to precipitation.
Technetium-99	200,000 years	β	Present as negative ion and absorbed to negligible extent, but very long half-life renders it effectively harmless.
Ruthenium-103* Ruthenium-106*	42 days 1 year	β, γ β, γ	Only partially absorbed by ion exchange or by precipitation owing to chemical complexity.
Iodine-131	8 days	β, γ	Present as negative ion and absorbed only slightly, but short half-life means that it soon decays to a negligible activity.

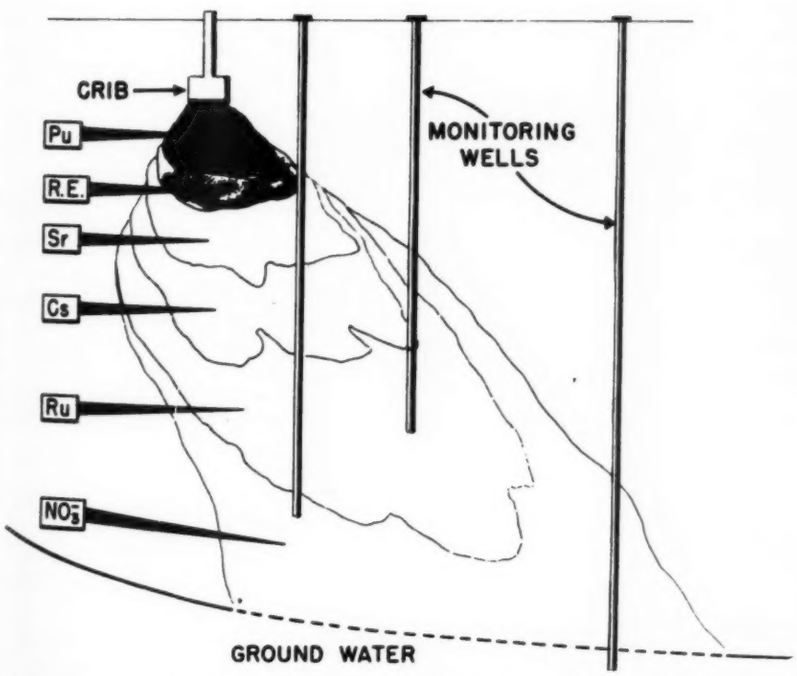
* Including radioactive daughter products of much shorter half-life.

embedded. The bulk of each particle may consist of fused oxides derived from the melting of the metal containers if the reaction has taken place at a reasonable altitude or near a water surface, or of fused glassy silicates if it has taken place near the ground, where large quantities of soil may be sucked into the hot reaction zone and fused, together with the other materials.

Leaching of fission-products

In the first British atomic test at Monte Bello, the frigate in which the weapon was placed was fused and disintegrated by the effect of the explosion, later to reappear as fused particles of iron oxide in which the fission products were embedded. Before the activity in this solid debris can be made available for transport in the soil and for root uptake, it must be leached from the particles by the action of rain-water or of ground-water, and it is an interesting fact that even the most soluble of the fission-products are only leached to a very slight extent from such fused materials; even in the neighbourhood of large industrial centres, where the ground-water may be appreciably acid, leaching will still be very slight. In fact, one of the methods at present being studied for the fixation of radioactive waste solutions involves absorbing the activity on to clay or soil and firing it to high temperatures in order to render it unleachable. This property tends to localise the contamination from such an accident, and also reduces its availability to the roots of plants, since the latter only take up chemical species which are dissolved in the soil-water. On the other hand, we should remember that there is a more direct route to animals *via* the material which is directly deposited on the leaves, in the case of plants where the leaves or upper portions are harvested, or eaten.

The radioactivity which is able to enter the soil in solution will be transported by movement of that solution throughout the soil, and this solution may contain many other chemical constituents in addition to the radioactive ones, *e.g.* dissolved carbon dioxide, chemical fertilisers, and so on. During the initial stages this solution will move downwards through the soil until it reaches the water-table, after which it will flow along the latter in the direction of underground waterflow. In the course of doing this the contamination spreads and may reach wells, springs or streams, which serve to spread it still further. In spreading, it occupies an ever-increasing volume and as a result suffers dilution; in addition, many chemical reactions may take place in the soil which tend to hold back the activity and limit its spread. It is important to remember that since the activity is continually decreasing, because of radioactive decay, hold-up for a sufficient length of time ultimately renders it quite harmless, although for long-lived species this requires a very long time.



Movement of ions through the soil following discharge of waste solutions at Hanford, Washington (Brown, Parker & Smith, courtesy of United Nations Association). Anions (nitrate) move readily and to a certain extent so does ruthenium (Ru). Cations are held more strongly, particularly the polyvalent, precipitable ones, such as plutonium (Pu), and the rare earths (R.E.). Caesium (Cs) and strontium (Sr) occupy an intermediate position, their retention depending almost entirely on ion exchange

This illustration should be read in conjunction with the table

Check to movement

The two types of chemical reaction which serve to hold up the movement of activity through the soil are precipitation and ion exchange. In the former certain chemical species in solution are converted into insoluble products which are absorbed on the soil particles and filtered from the stream of ground water. It is not possible to precipitate all of the elements present by reaction with the soil, but highly alkaline calcareous soils, or well-limed soils, will precipitate many of the fission-products, notably the rare earth elements, such as cerium-144, and to a slight extent the highly toxic, long-lived fission-product strontium-90. The latter would be more efficiently removed as the phosphate on an alkaline phosphatic soil. Acid soils are rather inefficient for precipitating fission-products, unless the solution travelling through the soil also contains appreciable quantities of some element, such as iron in the oxidised state, which is precipitated under the more acid conditions and which will act as a carrier for co-precipitation of the rare earths.

Chemical factors

The alternative mechanism of ion exchange in soils is intimately bound up with plant nutrition and the application of fertilisers to soils. In this, soluble chemical materials applied to the soil are themselves made available to plants by being exchanged within the chemical complex of the soil for other chemical species already present. For example, we may apply potassium as potash, thus replacing part of the calcium in the soil complex with potassium and thereby making the latter available to the plant over an

extended period; if it were not for ion exchange, which allows the potassium to enter into chemical combination with the soil, the potash would be very rapidly leached out by ground-water and much larger doses would be required.

In the same way the radioactive species present in the solution may be exchanged for the chemical elements already present in the soil (usually calcium, potassium and, to a lesser extent, magnesium and sodium); the activity tends to be held back and to be replaced in the water flow with inactive elements from the soil. Fortunately, elements which are efficiently removed by ion exchange include those which are not precipitable under any normal conditions, *e.g.* caesium-137, while those which are precipitated under alkaline conditions are also absorbed by ion exchange under more acid conditions where precipitation is not possible.

Importance of clay fraction

Since the base-exchange property of soils is intimately bound up with their clay content, the proportion and type of clay mineral present determines in part the extent to which this mechanism operates. Most soils, even barren sandy ones, contain some clay and exhibit base-exchange properties, but the quantitative extent of this property varies widely. Although the base-exchange capacity of a soil may be quite low, *e.g.* for a very sandy soil, this may still be equivalent to uptake of a very large amount of activity when calculated on a tonnage scale. For example, if we take a soil with a base-exchange capacity of only 0.01 milli-equiv. per gramme at breakthrough, *i.e.* when the activity escaping from it on percolation becomes appreciable, this is equivalent to saying that one ton of the soil will absorb about 40,000 curies (C) of caesium-137 before it begins to leak through; such an amount is equivalent to 40,000 g. of radium.

Thus even the very small amounts of clay in sandy soils can achieve appreciable decontamination on a large scale; it is found, in addition, that many fission-products, such as cerium, are also absorbed on other fractions of sandy soils, in particular on the felds-par fraction, where they seem to be deposited as an insoluble coating on the grains. Other silicate minerals possessing appreciable, or even high, base-exchange capacities are found in some soils, *e.g.* glauconite or green-sand, which has been much used for water-softening because of its exchange properties. Such examples are not common, however, and the base-exchange properties of most soils are largely attributable to the clay minerals present. In addition, humus possesses considerable base-exchange properties, so that a soil rich in humus will also cause appreciable localisation of any contamination, although this effect will only be noticeable in the upper layers. Although the problem of ion exchange in soils is an extremely complex one, some progress has been made in recent years in explaining it on the basis of the clay minerals present.

Work at Harwell on the exchange properties of various local soils and of sand and clay fractions separated from them, together with a knowledge of the exchange properties of the pure clay minerals, has shown that a definite correlation exists between the exchange capacity and the proportion and type of clay mineral present. In applying such results to soils in the field it should be remembered that further treatment of the soil may modify the uptake of radioactivity considerably, *e.g.* since ion exchange operates for all the ions in the soil solution, the application of fertilisers or of lime will tend to lower the uptake of radioactivity, or to release that already absorbed; lime will, of course, tend to precipitate some of the activity as well.

Caesium fixation

In soils containing certain types of clay mineral it has been found that caesium, which is one of the two important long-lived fission products, is fixed to some extent in that it is not completely displaced by treatment with chemical solutions. This situation is analogous to potassium fixation, which is well known among soil chemists and agricultural chemists. It serves to localise radioactive caesium to a certain extent and to hinder its rate of movement through some soils.

Iodine-131

These remarks apply to exchange of the positively charged ions, or cations, for which all soils except very barren sandy soils have appreciable capacities. The negatively charged ions or anions, such as chloride, sulphate, nitrate etc., are taken up by soils to only a slight extent, the anion-exchange capacity usually being only a few per cent. of the cation-exchange capacity; this is because the replaceable ions in the clay minerals are themselves largely cations. Fortunately, the longer-lived radio-active species are also present almost entirely as cations, and as such are absorbed; anionic members, such as iodide ion from iodine-131 (half-life eight days), soon decay to a negligible level of activity, so that the failure of the soil to absorb them efficiently is not important.

Ruthenium

There is one fission product, however, which does not fit neatly into the above picture. Ruthenium may exist in a great variety of different chemical forms and possesses a very complex chemistry. Although certain of its chemical forms are readily removed either by precipitation or by ion exchange, it is an experimental fact that the mixture of ruthenium species present in waste solutions is not completely absorbed on passage through the soil; the migration of ruthenium may, in fact, be used as an advance warning of the approach of the other active species, which follow it many months later. However, since ruthenium is one of the elements which is taken up to a lesser extent by plants, this is not unduly serious.

Table 1 summarises the properties of the more important fission products and their behaviour with respect to different types of soil.

Physical factors

Apart from these chemical factors, certain physical factors are also important in determining the spread of activity to new areas. If the water-table lies at a great depth, the rate of outward movement will be low, since the solution must percolate downwards to the water-table before it travels appreciably forward. In this respect also the local rainfall is important, since if this is low the movement of material through the soil will be low. The permeability of the soil and of the sub-surface formations is important; rates of water movement are in general much lower in chalk and dense, compacted sands than they are, for instance, in porous limestone. On the other hand, greatly accelerated movement may result if the formation

is prone to fissuring (as is common in chalk strata) or to the faults so often seen in certain rock formations. Consequently it is impossible to give a reliable forecast of what will happen in a given area unless it has been investigated thoroughly.

Disposal of waste

The deliberate use of the ground for disposal of dilute radioactive waste solutions is being studied intensively in the U.S.A. and two establishments —those at Oak Ridge and Hanford— have used this method of disposal for several years. Although the greater density of population and the increasing demands on water supplies render such a method most unlikely in this country, the results of American experience help us in striving to assess the possibilities of contamination spreading from incidents of the type we are discussing. Without going into detail concerning the American work, it may be said that of all the radioactive elements discharged into the rather clayey soils concerned, only ruthenium moves to an appreciable extent over several years and is, in fact, used to indicate the approach of the other, more critical elements, which follow much later. In one case at Oak Ridge, where waste solutions are being constantly discharged into unlined pits excavated in the ground, no caesium-137 has been detected in a borehole 6 ft. away after four years. At Chalk River, where after the accident to the NRX reactor 10,000 cu. m. of cooling water containing 10,000 C.* of activity was discharged to unlined trenches in the ground, measurements made 2½ years later showed that the activity had penetrated downwards to only a very slight extent. These and other results show that, in the case of local contamination of the ground, the chances of restricting the spread of contamination are good so far as ground movement is concerned. The major difficulty would appear to be the possibility of the activity being spread by birds or animals, either by direct contact or by eating contaminated crops; the latter could, of course, be harvested and destroyed as soon as possible and the ground limed in an attempt to precipitate some of the soluble activity and restrict its movement still further.

In the case of activity deposited in or very near to streams or rivers the position is much more complex. Although it might appear at first that its movement would be very rapid, there are many factors which may hold it back, such as deposition on the bottom or on the banks. Obviously the nature of the bottom, the rate of flow, and the depth of the stream are important; fast-flowing streams with pebbly bottoms will transport the activity much faster than sluggish streams with muddy bottoms. On the other hand, even after activity is deposited on the mud, it can be slowly transported by scouring due to under-water currents. Obviously, it is impossible to make any general predictions in the case of material which reaches a watercourse.

We see then that, in most cases of local contamination, there is no need to be pessimistic about the rapid spread of activity through the ground to more distant areas, except in exceptionally unfavourable cases where it rapidly reaches a suitable type of watercourse or where there is a very easy access to underground water *via* fissures or faults. Some spreading by animal life might occur, but this is partly controllable and, in any case, would probably be only a secondary factor. Crops growing on the area of contamination would need to be harvested under careful control and destroyed, and in order to make the land productive again in the shortest time, deep ploughing and fertilising would be useful. The former would turn over the soil, so that the upper layers in which the activity is initially located would be dug in below root level; the latter, under the influence of rain or irrigation, would help to release activity exchanged in the upper layers and allow it to percolate further down, until it was again exchanged upon fresh soil. In the case of general contamination, resulting from nuclear warfare, the spread of contamination to other areas is only important on the fringes of the area, but within the area itself the procedure of deep ploughing and fertilising, when radiation levels render it practicable, is still of value in lowering surface contamination (which presents a radiation hazard) and reducing the availability of active species to plants subsequently grown in the area.

* C=Curie

Leonard Hill's Visit to Australia

Mr. W. Leonard Hill, Chairman of the Leonard Hill Technical Group, now on a world tour, recently spent three weeks in Sydney, Australia, where he was received by a friend of many years' standing, Sir Norman Nock, former Lord Mayor of that city.

Among Mr. Hill's visits was one to the Anchor Flour Mills, where he was received by Mr. Dunkley and his fellow directors and entertained to lunch. Anchor are subscribers both to WORLD CROPS and its associate publication, *Food Manufacture*. Mr. Hill was told that the milling trade is temporarily experiencing a slack period, owing to the poor wheat crop this year.

There is great need in Australia for soil scientists, says Mr. Hill. The importance of trace elements is being increasingly appreciated, though some people seem to think it is possible merely to buy a packet of these substances from their seedsman, sprinkle them on their land and so get bumper crops. The other great need is water. Australian scientists are making great efforts to perfect evaporation-retarding films which can be spread over reservoirs and lakes.

Technical News

The March contents of *Dairy Engineering* include ' Mechanical Handling Developments in the Dairy ', ' Planning the Larger Dairy ' by D. Kingston, 'A New Hard-wearing Flooring for Dairies ', and ' Packaging Developments for the Dairy Industry '.

Articles included in the March issue of *Fibres* are ' Weft Spinning in Automatic Looms ' by H. Marsden, M.C., M.SC., F.T.I., and ' Latex and Rubber Spreading and Processing' by C. Moss.

Manufacturing Chemist for March is a special number featuring Fire Protection; it also includes Progress Reports on ' Fertilisers and Plant Nutrients ' by D. Hopkins, ' Therapeutics ' by S. J. Hopkins, and 'Antibiotics ' by P. B. Dickenson.

The March issue of *Food Manufacture* includes articles on ' Fruit and Vegetable Canning ' by Denis Dickinson, and ' The Estimation of Ascorbic Acid in Foods ' by H. Moor.

The March number of *Atomics* contains articles on 'Liquid Metals and Nuclear Power' by C. D. Boadle, 'Radiocarbon Dating ' by W. R. Loosemore, and ' Welding in the Atomic Energy Industry ' by I. H. Hogg.

The Economics of Yugoslav Agriculture

PROF. STANE KRAŠOVEC

(our Yugoslav Correspondent)

In a previous article in this journal it was pointed out that the economic advancement of Yugoslavia was being retarded by the relative stagnation in agricultural output, while the population, particularly in urban areas, was rapidly increasing. The problems of agriculture were actively discussed by Parliament in October 1957 during the debate on the Economic Plan for 1957.

IN the course of the debate on the Economic Plan for 1957 it was stated that manual workers and clerical employees were demanding substantial increases in wages and that, without a corresponding increase in production, this would inevitably lead to serious inflation. The Government agreed that investment of its funds should be mainly to encourage the production of consumer goods and that there should be severe economies on other items of national expenditure. In agriculture it was abundantly clear that, without additional capital, it was not possible to step up the production of food. It was further agreed that exports of food should be stopped and imports encouraged, so that food supplies would be maintained, and the danger of rising food prices would thus be averted.

The Government now attached great importance to increased investment in agriculture in order to obtain greater productivity. In the past there had been over-emphasis on heavy industry; in fact, only 9% of the national income had been invested in agriculture. In addition, there was private investment in agriculture of about the same amount, but the bulk of this had been spent on building new houses to replace those which had been destroyed during the war.

The Plan for 1957, which was submitted for approval, provided 17 billion* dinars for water control and 12.8 billion dinars for mechanisation, with some provision also for the supply of fertilisers and seed (wheat and hybrid maize). In 1953 only 10 kg. of fertilisers per ha. was applied to the land; by 1956 this figure had been increased to 53 kg. per ha.; it was proposed now to increase this to 80 kg. during the current year.

The money to be provided for water control was mainly to be spent in Vojvodina, the 'grain-bowl' in the north-east, which is alternately menaced by drought and floods. The proposal for a Danube–Tisa–Danube canal has also been revived and work on its construction was to begin during the year; in addition, the 200-year-old canal system in this region, which has been neglected and is deteriorating, was to be properly maintained.

There was a division of opinion regarding the advisability of concentrating investment in Vojvodina. Those opposing the proposal were overlooking the fact that for 10 years this region, which is without mines or heavy industry, has been selling its wheat and maize at a controlled price, which allowed little or no return on the money invested in agriculture. They insisted that the Government proposal would hinder the progress of the rest of the country. There were other areas, they said, which are not liable to floods, and which could with very little effort and expense be made more productive, so that it would not be necessary to import grain. Most of these areas are still being cultivated in a primitive fashion and a considerable part is not even being developed; and they consider that yields can be substantially increased by providing improved seed, by the use of fertilisers, and by better methods of cultivation in these areas. They urged that import taxes on fertilisers should be reduced and fertiliser factories should be established in Yugoslavia.

Doubt was expressed whether such broad credit facilities would be fully used. Indeed, a high percentage of the money provided in previous years had not been taken up in spite of the fact that over half of the peasant farmers do not possess any draught cattle. The policy of low prices for agricultural products was denounced, as well as the policy of limiting the ownership of land to 10 acres, which was leading people to take up secondary occupations outside agriculture.

The Croatian leader, Mr. Bakaric,

Peasants in Vojvodina working co-operatively on an irrigation project; hitherto this work has not been carried out on an adequate scale

* billion = 1,000 million

who is an authority on agriculture, said that this was the age-old problem of 'Landflucht' (flight from the land). He said that the prices of all agricultural products, with the exception of wheat, had been established on the free market and that they all allowed a profit. There was no need for higher prices or for any administrative measures to prevent the peasants from taking up other occupations.

Objection was raised that the proposals overlooked the individual smallholder, who represented about 90% of the total ownership of agricultural land. He needed improved credit facilities and stable prices to stimulate him to greater effort.

Winding up for the Government, Vice-Premier Kardelj summed up the position and submitted his conclusions, which met with unanimous approval. Agriculture, he said, must be given the

A drainage canal, built during the last century, now choked and neglected. No maintenance has been done since 1910

funds necessary for its advancement towards greater productivity, and agricultural co-operatives could induce the agriculturist to make better use of the credit facilities provided so as to raise his productivity with his present implements and subsequently by the gradual introduction of mechanical aids and by some improvements in the irrigation system. He asked for more funds and more power to be given to local authorities (the communes and communities of communes). The new administrative units should be as strong, as wealthy and as independent as the nation could afford.

There was a belief, not only abroad, but also within the country, that Yugoslav agriculture was ruled by the 10-year plan, as propounded some years ago. This was only a plan; it had never become law: it can be amended and during 1957 it will be given a thorough examination and the Government invited the co-operation of all concerned. In the same way a study will be made of the relationship between wages and productivity, a subject which will be given top priority.

Better Seeds: Better Crops

(*continued from page* 97)

however, made in private testing stations operating under licence, of which there are no less than 106. Licences are only granted to stations that are properly housed, equipped and staffed, and there are also a number of safeguards. (1) A training course is held annually at Cambridge for 20 would-be analysts. (2) Licensed testing stations are regularly inspected. (3) Part of every sample has to be kept for three months for check-testing, if so required. (4) Identical samples from bulked seed are sent periodically to all licensed stations for examination.

Identification of Variety *by G. P. Carson* (*Systematic Botanist, N.I.A.B.*)

Variety is the basis of modern crop production and seed selection, for variety can make all the difference between profit and loss.

(1) A variety may be the progeny of a single plant which has resulted from many generations of self-fertilisation—but mutations can occur.

(2) A variety may be produced by crossing with a cross-fertilising crop.

(3) A variety may be a population of inter-breeding individuals with characteristics distinguishing them from other populations.

(4) A variety may be a first-generation man-made hybrid and must be made anew each time by crossing the parental lines.

In opening the ensuing discussion, *Dr. Herbert Hunter* (former Chairman of the Institute) quoted the saying that no two plants in this world are alike. Cross-pollinated plants, he said, are never pure and are not biological entities. To get a pure strain you have to make millions of crosses, but it is not essential or good to have absolutely pure stock. All varieties are splitting up—mostly in a small way—but sometimes in a big way. At no time do you arrive at absolute finality and in testing seeds for variety all you are doing is to eliminate the outstanding rogues and forms.

More and more workers will be required to carry out the ever-expanding activities of the National Seed Testing Service, which is now being enlarged and when finished will be one of the finest stations in the world.

Choice of Wheat Varieties for Spring and Autumn *by E. G. Thompson* (*Head of Crop Improvement Branch, N.I.A.B.*)

There are no perfect varieties of wheat on the recommended lists; all have strong and weak points.

The present list of spring and winter wheats includes those grown principally for yield and those recommended for grain quality, including the milling and bread-making varieties. The characteristics of a number of named varieties are discussed.

Wheat Varieties and Disease *by C. C. V. Batts* (*recently Botanist, N.I.A.B.*)

The cheapest and simplest way of controlling plant disease is to grow resistant varieties. The National Institute of Agricultural Botany determines the reaction of varieties to disease, first by assessing diseases present in the field, and second by actually inoculating plants with the disease.

The resistance of different varieties to eyespot, mildew, black rust, yellow rust and loose smut is discussed.

The Farmer's Choice of Cereal Varieties *by J. A. McMillan* (*Senior Education and Advisory Officer, N.A.A.S.*)

Formerly farmers themselves chose a variety of wheat and kept to it; today experience has shown how profitable it is to introduce varieties whose merits have been proved in field trials.

Without the Institute, there would be little reliable information on the merits of the many hundreds of varieties now available and continually coming on the market. It may take some 15 years to breed and establish a new variety and very few of the selections prove worthy of multiplication.

The best stiff-strawed varieties should be given the right conditions to develop their full potential—better cultivation, more liberal fertiliser application and better weed control.

How Should we Build for Farmers?

HANS DESCHEPPER

Intensive agriculture, with its many ramifications and its use of machinery and motors, can no longer find accommodation in conventional farm buildings erected by conventional building methods.

New methods

Experiments have been made to apply new methods to agricultural building. The results vary greatly. We are not referring here to differences which may be due to varying natural conditions which demand different kinds of buildings for different countries. There is only one development which can be observed everywhere: the cost of building has risen to an extent that the building capital available to farmers is no longer adequate. This has resulted in a general tendency towards cheap—even primitive—building methods in agriculture.

Primitive buildings have a very short span of life and a farmer during his own life can be expected to spend the same amount of money whether he invests it on permanent agricultural buildings at once or on primitive buildings in several instalments.

If he decides on permanent buildings, the use of new building materials and building techniques will often dispense with the need to set aside money for the upkeep and repair of the buildings. With conventional building methods considerable sums of money had often to be set aside for this purpose, unless, of course, the farmer decided not to do any repairs and resigned himself to find his farm buildings in conditions which can only too frequently be observed in German agricultural areas.

Principles

The following principles govern all buildings for agricultural purposes:

1. The man-power problem in agriculture restricts the number of farm types and necessitates certain farm sizes.

2. The man-power problem in the building trade necessitates the employment of suitable building techniques and consequently building types.

3. Lack of permanence or huge maintenance costs may outweigh the advantages of a small initial outlay.

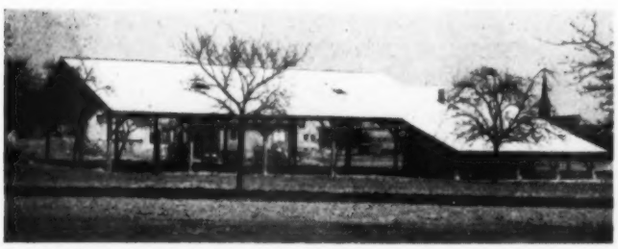
These principles have been applied to a system of construction which has been worked out in Darmstadt, Western Germany, with the active cooperation of the Bureau of Civil Engineering (Statics) under the direction of Prof. Kleinlogel. The system is flexible and can be adapted to the varying needs and purposes to which a building may be put.

In many German villages the farms are built so close to one another that conversion seems a hopeless task

The method of construction is to build a kind of hall on groups of binders.* Wood, steel and reinforced concrete, or both, can be used for this purpose, as has been shown in Switzerland, the Netherlands and Great Britain.

Owing to the lack of experienced craftsmen and suitable machinery, such a building can hardly ever be assembled locally on the actual building site. Prefabrication is the answer to this problem. Because of the versatility of the binder system of construction, it is possible to concentrate on a few types for which prefabricated units can be mass-produced. This in turn greatly reduces the initial building capital required.

*Binder : a timber girder which supports the bridging joists used in the construction of large floors.



(Left) *Experimental type of ' primitive ' building without walls. It is built of round timber. Crops and cattle are housed in one large hall-type building, no special provision being made for their accommodation.* (Right) *This is a view of the same primitive building after two years' use*

Large hall-type granary with hoist installed. In the background are reinforced concrete silos. Walls and roof are assembled from large prefabricated units

The assembly of such binder constructions generally requires special hoisting gear, which can be made to pay its way if it is also used for the assembling of other prefabricated units for roofs, walls, floors etc. Prefabricated ceiling units have been in use for some time, but in modern agricultural buildings there is a tendency to do without ceilings which make mechanised transport within the building rather awkward.

Suitable prefabricated units for roofs, walls and floors, made from conventional building materials, have now been produced. Special attention had to be paid to the cattle shed walls and floors, which in German climatic conditions have always presented a difficult problem.

Three different parts were designed for the floor of the cattle shed which should meet all requirements. The traditional multi-layer construction was reduced to a two-layer system.

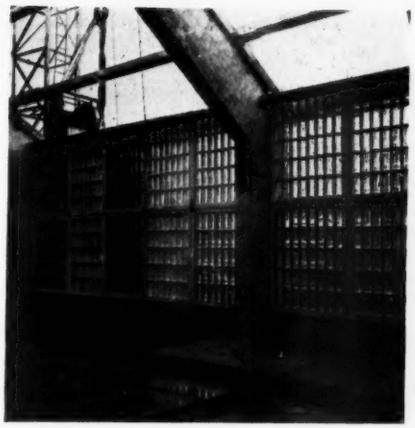
Two very different constructions have been developed for the wall of tie-up cattle sheds, the usual type of cattle shed in Germany because of the straw problem.

Cattle sheds

The first of these two methods uses lightweight building materials with a high degree of heat insulation and consists of one single sheet, which is put between the binder supports.

The second method uses glass tiles of various sizes. Here no claim to a high degree of heat insulation is made, but this disadvantage is outweighed by two great advantages: the maintenance costs are practically nil and the glass tiles can easily be cleaned with water. It may even be expected that the inevitable condensation of water will give off heat inside the cattle shed and to some degree take the chill off the air entering through the ventilation slits at the top of the wall.

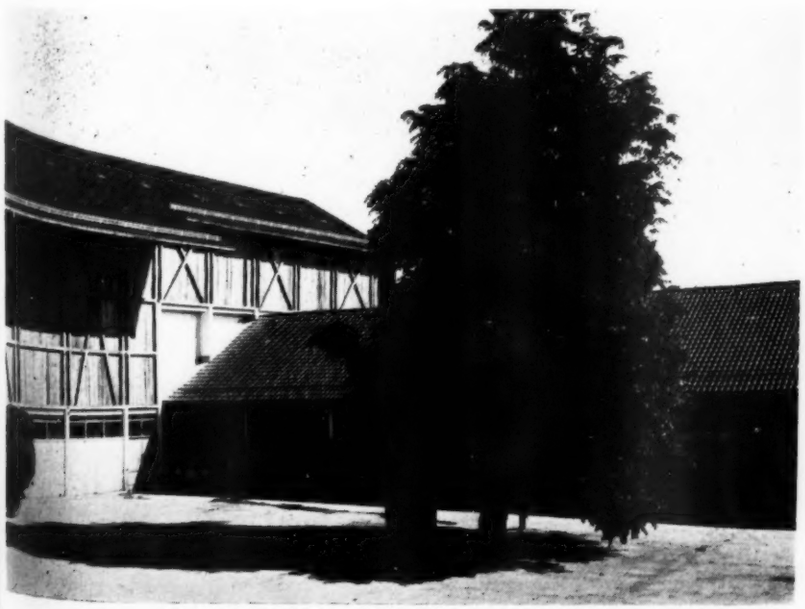
It is obvious that prefabricated units of this kind will in themselves be more expensive than comparative parts (*e.g.* a whole byre wall) made from conventional building materials. A clever architect, however, who takes a comprehensive view of his total design will manage to keep the total expenditure on the same level and it may even be expected that as soon as mass production of the prefabricated units has begun the cost will go down.



A cattle shed being made with pre-fabricated glass-tile wall units and pre-fabricated floor slabs. The heat insulation may be poor but maintenance costs will be negligible

The policy of rural resettlement, which has been carried through in the Federal Republic of Western Germany since full-scale country planning started, will result in the introduction of all these methods and will even necessitate them. Besides, the system has already been proved right wherever it has been applied in Europe during the last few years.

Translated by M. Pottlizer



View of farmstead built of reinforced concrete and other prefabricated units

British Tractors in Kenya

Reports continue to arrive regularly from East Africa concerning the excellent performance put up by British-made tractors working in adverse conditions.

The most recent deals with a demonstration of the 50.5-b.h.p. International BTD-6 with a three-furrow 14-in. plough. The occasion was a field day organised by the Royal Agricultural Society of Kenya, with the assistance of the Agricultural Department, on the Department's experimental station at Kitale.

The job of breaking the virgin land was extremely tough, but the British International tractor produced excellent work and attracted great interest.

The Wheat Situation in Australia

E. J. DONATH
(*University of Melbourne*)

MOST of the wheat has been harvested and it is estimated that the 1956–57 crop will be 127 million bushels, 35% less than last year, and the smallest crop since the last drought in 1946–47. The main reason for the small harvest is the extremely low acreage of 7.8 million acres planted to wheat, the lowest since 1919–20, excluding the war years, when wheat growing was restricted in Australia. Too much rain during the first half of 1956 made fallowing and sowing very difficult; there was also a slight change away from wheat to cattle, and barley aud linseed, especially in Queensland.

In spite of the unfavourable start in antumn and early winter, the average yield of 16.3 bushels per acre is satisfactory. Yields have been very high during the past 10 years, averaging 16.7 bushels per acre, and in 1955–56 the yield per acre was 19.2 bushels—an all-time record.

The low crop in 1956–57 is a blessing in disguise, as it will enable Australia to get rid of a rather large surplus of about 100 million bushels. We shall have about 200 million bushels to dispose of in 1957; about 60 million bushels are needed locally, thus leaving about 140 million bushels for overseas sales. In 1956 we sold about 130 million bushels, and if we sell about the same amount this year our silos will just hold a safe working carry-over at the end of 1957, when the new harvest will come in. We must not forget, however, that we have not had a drought for 10 years.

Destination of exports

With the new U.K.–Australia Trade Agreement there is an assured market for at least 28 million bushels in Great Britain and an additional 30 million bushels are covered by the Third International Wheat Agreement. Without our carry-over we would just be able to cover these quantities from the current harvest. There have been significant changes in the direction and composition of Australia's overseas trade in wheat. Prior to 1939 more than half of our wheat was sold in Europe (mainly to the U.K.), whilst in recent years the bulk of our wheat has been sold to non-European countries (mainly in Asia). In 1955–56 the U.K. bought only 20% of our wheat exports and during the last four years has only bought an average of 16 million bushels, compared with a pre-war average of 41 million bushels. Japan has now become a significant buyer, taking 12%, and Japan bought mainly the high-protein Queensland wheat, for which it paid prices above that of the F.A.Q. grade. Of the 50 countries buying our wheat, large quantities went to New Zealand, Indonesia, West Germany, India and Ceylon.

Unfortunately, there has been a decline in export of flour; before the war Australia was the leading flour-exporting country, doing a quarter of the world's trade. Today our mills work short shifts because the U.K. and other importing countries prefer to mill their own flour, mainly in order to have the by-products of bran and pollard. Ceylon is Australia's largest market for flour. There is a great deal of anxiety about India's three-year agreement with the U.S.A. for 3.5 million tons of wheat to be paid in Indian currency, as India has been our second best customer for a number of years.

Recent developments

Nearly all wheat will soon be bulk-handled, as silos have been erected in South Australia and Queensland; at Pinkenba, near Brisbane, a bulk wheat terminal has been finished with a capacity of 1.3 million bushels and ships can be loaded at a rate of 800 tons per hour.

In September 1956 the Victoria Department of Agriculture released a new variety, Olympic, which is higher yielding and has a better bread-making quality than that of the varieties grown commercially in Victoria. Olympic is a mid-season wheat, producing cream-coloured ears on a fine medium height straw, and has been classified as a 'medium strong wheat'.

Last year the Australian Wheat Board began to detain all wheat with more than 5% admixture of foreign matter and/or unmillable grain; this ruling has made our wheat very clean, as many parcels contain hardly 2% material to be cleaned before milling.

Aerial view of grain elevator, silos and shipping pier at Geelong, Australia

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Coming Events

Trace Elements.—The Agriculture Group and Bristol Section of the Society of Chemical Industry are arranging a three-day symposium, entitled 'Trace Elements in Soils, Plants and Animals' at Bristol on 10-12 April, 1957.

Crop Protection.—The 4th International Congress of Crop Protection will be held in Hamburg, Germany, from 8–15 September, 1957.

Further details may be obtained from the Biologische Bundesanstalt für Land- und Forstwirtschaft, Messeweg 11/12 Braunschweig, Germany.

Land Development. — An International Seminar on Land Development for Agricultural Uses is to be held in Holland during May. The conference will deal with land classification, land reclamation, land settlement and water control. Enquiries should be addressed to the Secretary, Organising Committee, International Agricultural Study Centre, 32 Prof. Ritzema Bosweg, Wageningen, Netherlands.

Royal Show.—The British Royal Show is to be held this year at Norwich in Norfolk from 2–5 July.

The 28th International Agricultural Machinery Exhibition will be held, after a lapse of two years, from 5–10 March in Paris at the Porte de Versailles ground.

[Organisers of forthcoming international agricultural events are invited to send particulars to the Editor.]

A Powerful New Tractor

MORE power is the keynote of the new David Brown '900' tractor, which was presented for the first time at the Smithfield Show. More power—which will make it possible to use a four-furrow plough at a fast speed where soil conditions are normal, or a three-furrow plough, up a 1:5 slope, in a soil covered with snow and ice. Such a tractor will be particularly useful for hard and compacted tropical soils riddled with termites as a result of long-neglected cultivation.

Compared with the 30D series, the new model, with a rating of 40 b.h.p., has 15% more engine power. This has been achieved by incorporating the latest developments in fuel pump and injection equipment, so as to increase the working speed of the engine, obtain higher thermal efficiency and reduce fuel consumption. The stresses on the component parts are, however, no greater, because the compression ratio of the engine has not been increased and is still 16:1.

This compression ratio makes for easy starting from cold and better idling speeds than if the compression ratio were increased. The transmission has been improved by making an increase in the final gear reduction, so that it is possible to take advantage at the drawbar of the extra power now made available; this to the farmer means extra output.

In redesigning the transmission the opportunity has been taken to centralise the engine transmission between the wheels, so that wheel adjustment is thereby simplified, and with the introduction of an exceptionally strong drop-forged front axle a wider range of wheel settings (52 in. to 76 in.) is available in 4-in. steps by means of sliding extensions.

Considerable care has been taken to achieve the correct power/weight ratio. In consequence the weight of the tractor (approximately 4,000 lb.) is sufficient to take advantage of the increased engine power, but is still not too heavy for rowcrop work to be undertaken in the spring, when undue weight on the land is undesirable.

The extra traction can be amplified by a traction control unit, which is now fitted as standard on all David Brown tractors. This unit makes the maximum possible use of weight transference of implements to the tractor rear wheels, while at the same time maintaining positive depth control.

The new '900' David Brown tractor. A full three-furrow machine at any time, the '900' tractor can handle a four-furrow plough in normal conditions, and it can also be operated with the David Brown 'Albion' combine-harvester

The '900' tractor, in addition, embodies substantial improvements in manoeuvrability, for not only has the steering been made lighter by the introduction of 25% lower gearing, but the steering lock has also been improved to give an exceptional turning radius of 7 ft. 8 in. in either direction.

There are also a number of refinements. For instance, the entire one-piece bonnet is quickly detachable in that it can be completely removed by one man in a few seconds simply by detaching the exhaust pipe with its special clip-on attachment and loosening two wing nuts. The engine and its ancillary components are also directly accessible because the fuel tank and the batteries are well out of the way under the seat of the driver. Larger mudguards and a rubber-cushioned pan seat improve his working conditions.

In addition to many new and improved features, this attractive machine includes the well-proven David Brown characteristics, *viz.* twin-range gearbox giving six forward and two reverse speeds; two-speed p.t.-o. and pulley; overload release; independent foot brakes; and the unique traction control unit, previously mentioned, which gives increased working capacity, lower running costs and enables the tractor to be operated when ground conditions are difficult.

Oat-rust Trials in Australia

An extensive programme for testing the resistance of hybrid oats to crown rust is under way at Grafton, New South Wales. The oats varieties under test are advanced hybrids. Epidemics of crown or leaf rust of oats occur often in coastal crops and in spring-grown oats on the tablelands; the disease sometimes seriously affects production.

Seed Potatoes Receive Atomic Rays

Scientists in the U.K. are treating seed potatoes with atomic radiation to delay sprouting. The experiments are said to have had some success and it is thought that the atomic treatment of seed potatoes could have tremendous possibilities for extending Scotland's seed export trade to countries with a late planting season.

NEW PUBLICATIONS

An Introduction to the Botany of Tropical Crops

By L. S. Cobley, B.SC., A.I.C.T.A. Pp. 357, illustrated. London: Longmans, Green and Co. Ltd. 1956. 37*s*. 6*d*.

There is a dearth of up-to-date books on tropical agriculture and we accordingly open a new book on the botany of tropical crops with keen anticipation. The plants are here treated in 12 groups, according to their uses, as cereals, fibre plants, oilseeds and the like, each group having a chapter to itself. The crop plants comprising each group are described in turn, and for each plant we are given its origin and distribution, a botanical description, including its family, habit, flower and fruit characters, and the nature of the product derived from it. More than 140 plants are thus described.

The author is a lecturer in botany and in his preface he states that the book is designed mainly for use by agricultural students and as an aid for all those who deal with tropical crops and their products.

Its first purpose, to be a textbook for students, it should accomplish admirably. The book is packed with knowledge of just the sort about which examiners are likely to be inquisitive. We can envisage a steady stream of students, who have studied well their ' Cobley ', passing their examination with distinction.

The other group of readers, those who deal with tropical crops and their products, are more difficult to satisfy, since their wants are varied and discriminating. As one of them, the reviewer felt there were quite a few things he could have done without. Under rubber crops the author describes species of *Landolphia*, ending up by saying, ' they are no longer of any importance ', which invites the reader's retort, ' Why waste space on them, then?' In place of fennel (hardly a tropical crop), lupin, ajowan oil and rocket cress the reader might well be grateful for more about crops that matter. The descriptions of such plants as oil palm and Hevea rubber are compressed to greater extent than their importance warrants and, given more space, the author might well improve on his account of the banana and its varieties. In his description of the flowering of the oil palm the author is confusing, if not himself confused, and to anyone with West African experience the omission of any reference to that much valued crop, the kolanut, is hard to understand.

It is, however, ungracious to stint a welcome to this book because it does not conform precisely with our ideas of what it should contain, or even because it has its weak points. It covers ground not occupied by any other book and will earn its place, not only in students' studies and in agricultural libraries, but also as a reference book on the desks of many interested in tropical crops.

The lists of relevant literature at the end of each chapter will be of service, though study of them reveals some notable gaps. The illustrations are many, but of mixed quality, jute being represented by an admirable stand, but bananas by a deplorable example of bad cultivation. An attractive picture of coffee, cited as *Coffea stenophylla*, is not at all like this species.

T. A. RUSSELL

Diseases of Fruit Crops

By Harry Warren Anderson. Pp. 501, illustrated. London: McGraw-Hill Publishing Co. Ltd. 1956. 64*s*.

This book, written by a well-known American specialist in the subject, deals fairly comprehensively with the various disorders of hardy fruit crops. The bulk of it is concerned with the parasitic diseases, including those caused by nematodes, but reference is also made to the non-parasitic diseases of these crops.

An introductory chapter dealing with the barest elements of general plant pathology is followed by 12 chapters describing the various diseases, arranged under natural groupings of the host, *e.g.* pome-fruits, drupe- or stone-fruits, brambles, grapes, strawberries, gooseberries and currants, cranberry and blueberry. The information on each disease is arranged in a now familiar pattern under headings such as history, geographic distribution, casual organism(s), disease cycle etc., and is concluded with a short list of the more important references.

The book was apparently conceived as an attempt to bring together all the information on fruit crop diseases in a way that would be valuable both to the research worker and the practising horticulturist. Whether it is ever possible to satisfy two such diverse interests at one and the same time is open to question. The fact remains that, apart from the introductory chapter, the book is really intended for the research, advisory and student plant pathologist, and there can be no doubt that in this aim Prof. Anderson has succeeded admirably. Readers outside the U.S.A. may be conscious of an undue emphasis on the North American scene, to which the author freely admits. This is perhaps understandable, but it is, nevertheless, a little unfortunate in a book that, after all, will become a standard international work on the subject. This disadvantage detracts little, however, from an otherwise excellent book. In its preparation the author will have earned the gratitude of fruit crop pathologists wherever they may work. Finally, Prof. Anderson writes in a refreshingly simple and lucid style. This is more than can be said of the authors of some modern textbooks.

J. E. CROSSE

General Genetics

By M. J. Sirks. Pp. 628, illustrated. The Hague: Martinus Nijhoff (Agents in the U.K. and Commonwealth: B. T. Batsford Ltd.). Translated by J. Weijer and D. Weijer-Tolmie from the fifth Dutch edition. 1956. 60*s*.

The first Dutch edition of this textbook was published in 1922. After revisions the fifth edition, now translated, appeared in 1951. Some references to the literature published since 1951 have been incorporated in the translation. In the last three decades both plant and animal genetics have developed rapidly in many new directions, and, as the author puts it in the preface specially written for the translated edition, most modern textbooks suggest that for genetics ' life begins at forty ' and neglect the work of the earlier investigators. He has therefore attempted ' to establish an equilibrium between genetics as it was built up before 1940 and genetics as it has developed since. Lest we forget '.

The subject matter is well arranged. After an introductory chapter on the concepts and methods of the study of

heredity, the application of elementary statistics in genetical research is illustrated. The next chapter surveys the theories of heredity advanced, mainly in the 19th century, before the impact of Mendel's laws, which, although formulated in a paper published in 1865, suffered neglect until their rediscovery at the turn of the century. Much in these pre-Mendelian concepts may seem somewhat bizarre to us now, and it is therefore perhaps salutary to be reminded in the following chapter, dealing with early experiments, that large-scale systematic hybridisation of plants was not carried out before the second half of the 18th century. Mendel's famous experiments on the pea, the first to place the study of heredity on a sound mathematical basis and reveal the mode of segregation of characters, are described more fully than in most textbooks and the exposition of subsequent developments in classical Mendelism is more readable than usual.

In the second half of the volume a survey is given of the progress achieved in elucidating various aspects of the nature and behaviour of the gene itself and of the chromosomes which contain the genes; other topics considered include the role of the cytoplasm, sex inheritance and population genetics. The final chapter touches upon the application of genetics in different fields, such as medicine, crop and livestock improvement, and even philology.

In so far as he is concerned with genetics up to 1940, Prof. Sirks is thoroughly successful, but his treatment of developments since then is less satisfactory. Some subjects of much general significance, notably modern research on the genetics of viruses and bacteria, are omitted. Others, such as the concept of the inheritance of acquired characters, the value of the colchicine technique as a means of increasing the chromosome number and the biochemical genetics of micro-organisms, are dealt with insufficiently, in view of the latest advances. The translation reaches an adequate standard, although it is marred by a number of non-English expressions and typographical errors. But, in spite of such defects, the work is a valuable addition to the list of genetics textbooks in English and is unique in the historical perspective it provides.

THERESA ASHTON

The Rabbit

By H. V. Thompson and A. N. Worden. Pp. 252, illustrated. London : Collins. 1956. 16*s*.

This is one of the specialised volumes in the New Naturalist Library, a series which now contains 10 volumes. The series itself is a valuable one and this book proves to be no exception. It is written by two expert authors in a scholarly manner, although at times one feels that reference is made to scientific terms that may not be understood by the average reader.

The authors have managed to steer clear of the usual run of books on the rabbit and have made it fit extremely well into the main theme of natural history. There are short accounts, of course, of rabbit physiology and reproduction, as well as a chapter on disease, but by and large the book deals with such questions as rabbit behaviour, ecology and methods of its control in the wild state. This means that the question of myxomatosis is dealt with mainly from the angle of this disease being a valuable tool to use in rabbit control. The moral question of its use is not debated.

Some valuable figures are given with regard to the damage caused to crops by rabbits and, more important, the increase in crop production resulting from expert rabbit control. The authors have dealt very objectively with this major problem of crop conservation and have managed to give a balanced account which should prove invaluable to many outside the realm of naturalists. This section of the book could quite well be reprinted or paraphrased at length in many of the farming journals.

The book should prove of value, not only to the general reader interested in natural history or wild life, but it should appeal to the veterinary and medical professions and to biologists. It could quite usefully be read also by farmers and sportsmen.

The book can be recommended as one which is unique in its approach to the rabbit and is generally easy to read apart from an occasional lapse into scientific terminology.

W. R. WOOLDRIDGE

Plant Nutrients

Reports have recently been issued by ' Potascheme ', of Madras, India, on important large-scale fertiliser trials carried out in India. NPK Pamphlets Nos. 1 and 2 demonstrate the great improvements in yield obtained by proper manuring of coconut palms and tapioca respectively. A detailed Second Report dealing with fertiliser demonstration trials to paddy in India during the season 1955–56 has also been issued.

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The Gold Coast Cocoa Farmer

The author of this book, Polly Hill (Research Fellow, University College of the Gold Coast), states that it was written as a first contribution towards the understanding of the social organisation of the cocoa industry. It consists of a collection of separate socio-economic reports on the Gold Coast farmer, which deal with the employment of labourers, the pledging of cocoa farms, and the income and expenditure of cocoa farmers. The raw material on which the reports are based was collected in 1954–55 in 10 field surveys in widely distributed places in the Gold Coast. The book is published by the Oxford University Press, price 16*s*.

*

Oils and Oilseeds

The Annual Review for 1955 of Oilseeds, Oils, Oilcakes and other commodities is published by Frank Fehr and Co. Ltd.

Owing to the difficulties inherent in the collection of statistics from the various producing countries, there is inevitably a considerable time-lag in the production of a review of this kind. The report states that for the greater part of 1955 the prices of oils and oilseeds remained remarkably steady, which, after the violent fluctuations of recent years, was welcomed by all sections of the trade. Prices began to move upwards towards the end of the year, when it became apparent that the production of olive oil would be below average for the second year in succession, owing to the severe damage done by the olive fly.

In the U.S.A. the continuance of the Government Support Programme encouraged large crops of soya beans and cottonseed; the Indian groundnut, cottonseed, sesame and rape seed crops were all larger than in 1954; in British West Africa there was little change in output; the Philippine

copra crop was again larger, and exports increased from 758,000 to 815,000 tons and exports of Ceylon coconut oil were also higher at nearly 100,000 tons.

It is considered probable that world production in 1955, expressed in terms of oil and fat, exceeded 1954 by nearly 1 million tons, an increase of over 8%. A warning is given that the time may well be coming when supply and demand may be weighted in favour of the buyers and then the premium for better quality or the discount for poor quality will be more pronounced.

According to the statistics of production and exports which are given, it may be deduced that the chief producing countries today are as follows:

Linseed:	U.S.A., U.S.S R. and Canada.
Groundnuts:	India, China and West Africa.
Soya beans:	U.S.A., China and Japan.
Cottonseed:	U.S.A., U.S.S.R. and China.
Palm oil:	British West Africa, Belgian Congo and Indonesia.
Sesame seed:	China, India and Mexico.
Rape seed:	China, India and Japan.
Copra:	Philippines, Indonesia and Ceylon.
Castor seed:	Brazil and India.
Sunflower seed:	U.S.S.R., Argentine and Uruguay.

The estimated production of oilseeds in 1956, expressed in terms of oil, is likely to be about 14 million tons, made up as follows: groundnut oil 2.7 million tons; soya bean oil, 2.3 million tons; cottonseed oil, 2 million tons; coconut oil, 1.4 million tons; rape seed oil, 1 million tons; linseed oil, 0.9 million tons; olive oil, 0.8 million tons; sunflower oil, 0.7 million tons; sesame oil, 0.6 million tons; palm oil, 0.5 million tons; palm kernel oil, 0.3 million tons; castor oil, 0.2 million tons; maize oil, 0.1 million tons; and wood oil, hemp seed oil and other vegetable oils, approx. 0.1 million tons each.

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Use of Metal Chelates in Plant Production

Iron chlorosis in plants can now be conquered by the use of new chemicals called chelates. This report is based on a series of papers presented before the annual meeting of the Western Society of Soil Science held at Seattle, Washington, in June 1956. They have been edited by Arthur Wallace, of the University of California, who has included additional information to bring the subject up to date. Price $1.50.

*

Copra Production

We have received the ' Report on a Tour of the Copra Producing Areas of the Far East and Western Pacific ' undertaken by H. D. Howard in January–April 1956. Amply illustrated by photographs and diagrams, this report comprises a comprehensive study of copra production methods in these regions and points the way to the achievement of further improvement in quality.

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Determination of Moisture in Solids

Information about possible ways of determining the amount of moisture in a wide range of materials—including crops, foodstuffs, wood, soil and biological substances—previously widely distributed in literature dealing with the separate materials and in scientific literature generally — has been assembled in this handbook, published by the British Scientific Instrument Research Association. Brief notes on each method are supplemented by selected literature references describing or exemplifying the method. Following each set of references there is a list of apparatus, obtainable commercially in Great Britain, for determining moisture by the method outlined. Price 7*s.* 6*d.*, post free in Great Britain; 9*s.* 6*d.* elsewhere.

*

Tristeza and Xyloporosis

We have received from the European and Mediterranean Plant Protection Organisation the report of the Working Party on *Tristeza* and *Xyloporosis* held in May 1956. These two diseases have caused heavy losses in citrus plantations in many parts of the world outside Europe and the Mediterranean. There is evidence that both already occur in certain areas of this region and, in presenting this report, the Organisation urges that no time should be lost in studying the recommendations made and taking steps to give effect to them.

The Altitudinal Range of British Plants

This supplement to *The North-Western Naturalist* gathers together particulars from different parts of the British Isles, which it presents in a handy tabulated form for reference. The information has been compiled from figures given in various county floras and journals and from observations made by the author, the late A. Wilson, F.L.S., F.R.MET.S. In the introductory pages he surveys various factors that determine the distribution of plants, both horizontally and vertically. This is the second edition, revised and enlarged in 1949. Price 10*s.* 6*d.*

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Alabama Polytechnic Institute

Bulletin 300: *Alfalfa Production in Alabama*, and a special leaflet, *General Fertiliser Recommendations for Alabama*, are the result of experiments and tests in Alabama, carried out by the Agriculture Experiment Station of the Institute over a number of years. Sections of the special leaflet deal with the use of soil tests and give recommendations for the use of fertilisers for agricultural and horticultural crops.

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Other Publications

We have received copies of the following publications:

Farmers' Guide to Plant Protection, 1957, published by Plant Protection Ltd., a pocket reference in which affliction and remedy are grouped under plant type, with an additional section on low-volume spraying. On the subject of low-volume spraying they have also issued a card showing the best times to treat various crops and rates of application.

University of Cambridge School of Agriculture Memoirs, No. 28, which contains a summary of the papers published by the members of the staff of the School of Agriculture and its associated research organisations during the period October 1955 to September 1956 and includes an article by Sir Frank Engledow (Review Series No. 11) on agricultural teaching at Cambridge, 1894-1955. Price 3*s.*

Annual Report for 1955–56 *of the East African Meteorological Department*, incorporating a report by the Director, for the period July 1955 to June 1956. Price Africa Shs. 2/50.

MACHINERY AND EQUIPMENT

Power Steering

Power steering now is available for the McCormick International Farmall 300 and 400 tractors, their Hi-Clear versions and the McCormick International 300 Utility tractor, it has been announced by International Harvester Export Company.

Manual steering effort is reduced considerably with this new hydraulic power steering device, the company stated, asserting that the driver's load is lightened particularly when the tractor is equipped with heavy front-mounted implements or loads. Power steering also is a big help when the tractor is being driven at low speeds or manoeuvred in close quarters.

Although power steering results in easier turning, it also serves to hold the tractor on course, regardless of rough, irregular terrain, eliminating side thrusts and shocks. The new power steering operates off the Hydra-Touch systems of the tractors and is available on new tractors or for field installation on tractors already in use. By taking its power from the hydraulic system of the tractor, the compact power steering attachment operates whenever the tractor engine is running. Manual steering is in standby reserve at all times when needed.

Reader Service

For further information on any item of machinery or equipment reviewed in this section please write to:

Reader Service,
WORLD CROPS,
Stratford House,
Eden Street, London N.W.1,
England

Tangential Spray Gun Nozzle

A new development in spray gun nozzle design has been announced by Alfred Bullows & Sons Ltd., which they claim is a major step forward in obtaining the maximum conversion of energy of the air passing through the fan parts to produce a fan spray.

In a conventional nozzle this energy is largely dissipated because the air parts are opposed, so that the two air streams strike into each other directly, and most of the energy is lost. By using a tangential arrangement of the nozzle horns, the kinetic energy of the discharged air is used to the full, as the two air streams pass tangentially across the face of the nozzle.

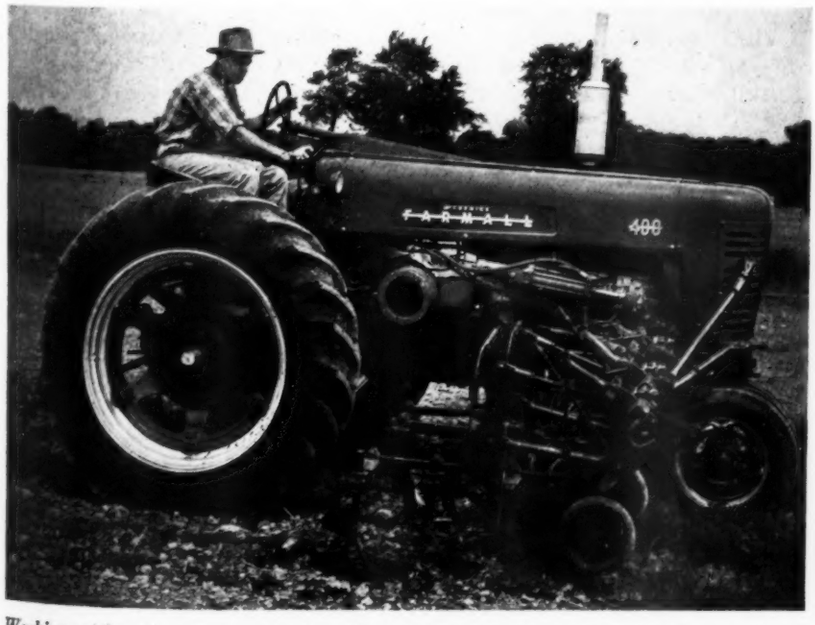
It is thus possible to provide a very wide spray and maximum coverage per pass of the gun, while breaking up a given amount of liquid, with the minimum consumption of air at minimum pressure. Quite startling savings can be shown on certain applications, particularly with electrostatic deposition, and it is frequently possible to reduce atomising air pressure from 50–5 lb./sq. in. with improved performance and corresponding savings in air and material.

The tangential arrangement of the nozzle horns in this spray gun is a new development in design and is claimed to achieve considerable savings in air and material

Fly Control in Dairy Barns

As the result of over two years' experiments, both in this country and in the U.S.A., it has been shown that insecticidal fogs can be satisfactorily dispensed in dairy barns for the control of house, stable and horn flies as well as mosquitoes and tabanids.

The equipment successfully used in U.K. tests was a rotating disk aerosol (Microsol Model 202) set to deliver a spray of droplets 30B40μ size. It was found that 1½ pt. of spray was sufficient to treat 80,000 cu. ft. The approximate cost of treatment worked out at 1½d. per 1,000 cu. ft. per day, using a synergised pyrethrum insecticide equivalent to 1.3% pyrethrins in odourless kerosene. The trials showed that a complete kill of all the flies present was possible without harm to cattle or personnel who had to work in the light fog throughout the milking period.



Working with a four-row cultivator, the operator of this McCormick International 'Farmall 400' tractor can swing his big machine round easily with one hand, while using the other to operate tractor or implement controls

Experiments in Wisconsin have been carried out with an air compressor unit capable of dispensing 5 fl. oz. of spray per minute at a pressure of 30 lb. per sq. in. The spray was dispensed at the rate of 1 fl. oz. per 10 ft. of barn length, a height of 8–9 ft. and width of 35 ft. A pressure of 8 lb. per sq. in. at the nozzle was found adequate for barns 60 ft. long but twice this pressure was required for barns 100 ft. long.

Fogging should be carried out shortly before milking, the doors and windows being kept closed during the application and for a few minutes afterwards. The spray used for the U.S. trials consisted of deodorised kerosene containing 1% piperonyl butoxide and 0.1% pyrethrins.

In both sets of trials it was noticed that considerable protection was also afforded to the cows in pasture, a feature believed to be attributable to the repellant properties of piperonyl butoxide. The reluctance of flies to enter barns up to a day after treatment was also put down to this cause.

Laboratory Grain Mill

For many purposes such as moisture determination and analyses of various kinds, grains, seeds, leaves, grass, roots, etc. have to be ground to a suitable fineness. It is important that the material should not be heated during the process as this may vitiate the subsequent tests. Since the moisture content may be high it is also important that the grinding process should not be such as will form a paste or clog the internal parts of the mill.

The C. F. Casella & Co. Ltd. laboratory grain mill works on a shearing principle which, they claim, will rapidly reduce the hardest grains to an even powder without an undue temperature rise and without clogging with a high misture content. The milling chamber of 2 in. (50 mm.) dia. has four blades projecting radially into it about $\frac{1}{8}$ in. (3 mm.). A centre block attached to the spindle of a constant speed motor carries four more blades of a similar type. The clearance between the two blades is adjusted to about 0.002 in. (0.05 mm.), the speed of rotation being 2,800 r.p.m. The course of one individual grain is somewhat as follows. As it enters the grinding chamber it comes to rest on one of the stationary blades so that when a rotating blade passes the grain it shears off a small portion. The grain will then probably pass on and come to rest against the next stationary blade where the process will be repeated. This goes on until the pieces are small enough to pass through the sieve which forms the lower portion of the chamber. More material is fed in from the feed funnel at the top, just enough being fed in to keep a number of grains circulating in the space between the rotating head and the inside of the chamber.

This laboratory grain mill works on a shearing principle and will rapidly reduce even the hardest grains to an even powder without an undue temperature rise and without clogging

The operation is thus extremely simple, as the material is merely poured into the conical-shaped funnel when it automatically feeds downwards until the complete amount has been disposed of. When the last few grains are being ground many of the pieces are flung upwards, but a baffle in the centre of the funnel prevents escape and they are gradually reduced in size until they pass through the sieve. Some materials, such as dried leaves, are too light to keep feeding down on their own account so an alternative funnel is available. This consists of a vertical tube, of $\frac{3}{4}$ in. (19 mm.) inside diameter, into which a loose-fitting plunger is placed whose weight causes the light material to feed downwards. A rod is attached to the plunger of such length that when a cross-piece at the top rests on the end of the funnel the plunger does not quite touch the rotating blades.

The size of the holes in the sieves controls the maximum size of the ground material. Three sizes in a wire mesh are available as standard with holes 0.02, 0.05 and 0.06 in. (0.5 mm., 1.27 mm. and 1.5 mm.) measured across the side of the square. The wire used is stainless steel so that both wear and corrosion are eliminated. The sieves are made into semi-circular frames which can be readily interchanged. Sieves are available with holes of $\frac{1}{2}$ mm., 1 mm. and $2\frac{1}{2}$ mm. diameter.

Control without Killing

The annual conference of the British Association of Science this year included a symposium on the balance of nature. It was pointed out that the rabbit had generally been exterminated throughout Britain only to be replaced by ever-increasing numbers of an equally destructive pest, the pigeon. Similarly in Africa, the steady destruction of big game has led to an increase in the zebra population and they are now a very serious pest to stock-breeders, because of the damage they do to cattle pastures.

In tropical countries fauna ranging from monkeys to elephants do considerable damage to estates, farms and smallholdings and the normal method of control is by shooting them. As a result the elephant population of Ceylon is rapidly diminishing and this noble and useful animal is in danger of extinction. The Blanch banger, a new machine for scaring birds and animals by a succession of explosions, provides a means of protecting crops at low cost and without the destruction of the pest. Such a machine is bound to have a special appeal in those countries where there is an objection to the destruction of any form of life on religious grounds and where watchers are armed with guns but cannot be relied upon to maintain a continuous vigil. In any case, it would be impossible to destroy all pests without serious consequences and it is better to have a machine which can give continous protection to crops rather than have to depend on a watcher.

An explosive gas is produced in the machine by the action of water on calcium carbide and the frequency of detonation can be adjusted to whatever is required. Furthermore, the machine is light and so can be moved from place

to place so that the birds and animals do not get used to the noise.

The machine could be used to protect extensive areas of paddy, fruit orchards and young coconut plantations. It is simple to operate and running costs can be as little as 3*d*. (15 cents) per day.

Light-alloy Irrigation Couplings

Details of irrigation tubing and couplings in 'Hiduminium' aluminium alloys, together with general information on irrigation, are contained in a brochure entitled ' Rain to Order ' recently published by High Duty Alloys Ltd., England.

Although little is known of their activities in this line in England, they have had considerable success in overseas markets, particularly Australia and South Africa, where the length of irrigation tubing in footage exported recently approaches the million mark.

H.D.A.'s Extrusion Division in Cumberland is an up-to-date plant equipped with a variety of presses up to 5,000 tons, capable of producing tubes in small and bulk quantities from 2-in. to 8-in. outside diameter for irrigation purposes. Experience in other fields, especially aircraft, has resulted in advanced production techniques, giving tubes of uniform thickness and high strength, capable of handling high pressures if required.

Couplings are of two types, both completely water-tight and quick-locking, fabricated from high-strength ' Hiduminium ' aluminium alloys. One is gravity die cast, the top being drilled and tapped, then plugged ready for 1-in. British Standard pipe fittings. It has a 20° flexibility. The other is a swaged coupling, is not drilled and tapped, and is only used in low-pressure supply lines.

A gravity die-cast coupling for irrigation tubing, made from 'Hiduminium' aluminium alloy

New Design of Alcon Pump

The redesigned 2-in. ' Alcon ' pump gives an increase in output from 7,000 to 10,000 gal./h. The total head has also been increased from 70 to 100 ft. Weighing 98 lb., the addition of carrying handles makes it easily portable by two people. The pump can be supplied powered by a Jap or Villiers engine, with a totally enclosed electric motor or trolley-mounted, and is suitable for use wherever drainage, water storage or irrigation problems arise.

Specification

The ' Alcon ' 2-in. pump is powered by a single-cylinder, four-stroke, air-cooled petrol engine developing 2.75 h.p. at 2,600 r.p.m., Villiers or Jap.

The unit consists of a centrifugal self-priming pump, spigot-mounted directly on to the engine crankcase, with the impeller fitted to the extension to the engine crankshaft. The engine and the pump combined are mounted on a baseplate.

Priming is by water recirculation. Efficient priming is obtained by the use of adequate recirculation passages, ample priming water and a large chamber for the separation of air and water. There are no priming valves or moving parts contained in the priming system and therefore no possibility of the self-priming characteristic failing. After the pump has been primed the output can be varied by means of the engine speed control. A simple non-return valve of hard-wearing rubber is fitted to the inlet, ensuring quick and efficient repriming under all circumstances even when the pump is working on ' snore '.

The ' Alcon ' 2-in. pump is powered by a single-cylinder, four-stroke, air-cooled petrol engine

A drain plug is fitted to the bottom of the body of the pump, draining the whole pump, including the volute. Complete protection is given against frost and cold weather.

The impeller is of the three-bladed open type, manufactured from close-grained cast iron.

The seal incorporated in the pump is a mechanical face type, utilising for standard conditions a centrifugally cast iron counter-face with a carbon running face and ' Hycar ' rubber sealing bellows. It is arranged to be in 50% balance, giving high efficiency of sealing with minimum pressure, thus ensuring long and consistent life. The faces of the cast iron counter-face and carbon running face are ground optically flat during manufacture and the seal is effective immediately after assembly without any necessity for a running-in period.

A hand-operated lever is fitted on the side of the engine cowl by which ready adjustment may be made to the speed of the engine, thus controlling the output from the pump.

Low-volume Spraying

Swingfire Ltd., the manufacturers of the well-known ' Swingfog ' portable sprayer, have now produced a knapsack spraying unit, the Swingfire ' Fontan ', which is exceptionally compact and light. This is a low-volume sprayer which can also be used for misting and dusting. It incorporates a two-stroke engine, which drives a blower; this in turn produces a large volume of air, which sucks in and effectively atomises the liquid and at the same time gives it a sufficient velocity to ensure spray penetration without any scorching due to blast.

With low-volume spraying considerably less liquid needs to be applied compared with normal high-volume spraying and there is in consequence a saving in labour, transport, material and time. Low-volume spraying with the ' Fontan ' gives a much finer droplet coverage, with less run-off and loss of expensive insecticide, fungicide, herbicide or disinfectant.

The ' Fontan ' can be used in any territory where a man can walk and it is extremely simple to use. In order that no vibration is transmitted from the engine to the operator, the engine and the blower are fitted to a flexibly mounted plate within the frame. In addition, the back cushion is suspended on spring mountings and the carrying straps are padded with foam rubber.

New Band Resaw

Produced to a specification developed in collaboration with their Swedish agents, A.B. Sigfr. Stenberg & Co., of Nassjo, Stenners of Tiverton Ltd. have just introduced a new band resaw, VHS.48".

The sawing assembly follows generally the standard lines of the Stenner VHK.48" resaw, with 48-in. pulleys, taking a 5½-in. wide saw and embodying the sturdy construction of that machine.

The machine can be supplied with heavier sawing units, taking 6-in., 7-in. or 9-in. wide saws.

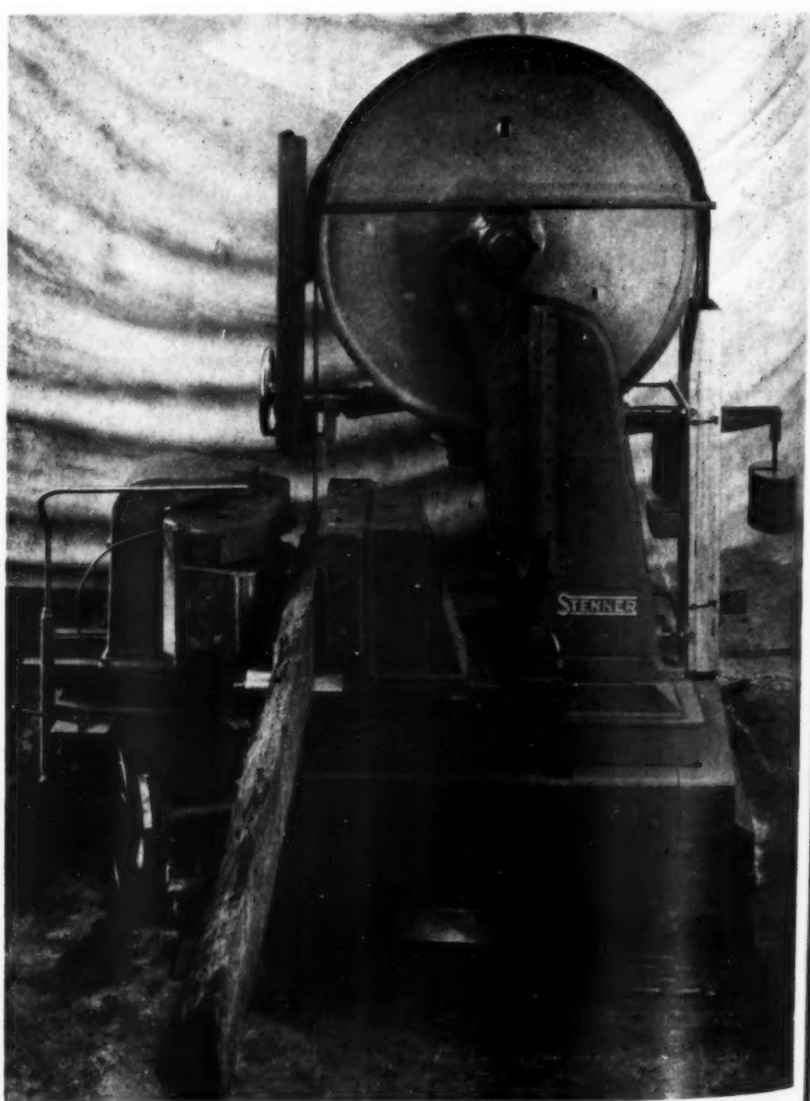
Designed specially to deal with wet timber and rough slabs, interesting new features are embodied in its feeding arrangements.

In the first place the feed gear is all hydraulic. Hydraulic motors drive the powerful serrated feed rolls and the four fluted rolls in the fence. The feed rolls are opened hydraulically and the fence moves hydraulically when being adjusted. As a result, feed speeds are infinitely variable from 20 to 200 ft. per min., and the operation of both the feed rolls and the fence is extremely quick and in some respects semi-automatic.

For instance, on the feed-roll assembly there is a guard plate which is also connected with the hydraulic opening ram; thus when this plate is contacted by a log it instantaneously opens the feed rolls just far enough to admit the log. Similarly, when a large log follows a small one, the feed rolls are immediately adjusted to take the thicker log. This automatic adjustment of the feed rolls provides a very important safety feature; if a man's clothing or arm should be caught by the feed rolls, the pressure of his body against the actuating plate would automatically open the feed rolls and release him. The feed rolls open up to 12 in. from the saw line.

The maximum opening of the fence is 9½ in. from saw line. There are 24 predetermined dimensions in this distance which can be quickly selected by pressure of the foot on a foot pedal and by, at the maximum, a 350° turn of the free-moving fence adjustment wheel. Intermediate dimensions are obtainable by using gauge slips. Fence adjustments normally take about half a second.

A brake is provided in order to speed up saw changing, this now being a standard feature on Stenner resaws.



The Stenner new band resaw is designed specially to deal with wet timber and rough slabs

The first machine of this type has been sold to a Swedish concern, where it will shortly be put to work behind a Stenner high-speed bandmill in a new mechanised sawmill.

The VHS.48″ is likely to prove valuable in mills where small and moderate-sized, round, wet timber is to be cut through and through. It can also be used as a conventional resaw, with a higher output than is usually obtainable with the standard machine.

Well Driller

The 'Consol' (Consolidated Industries Inc., West Cheshire, Connecticut, U.S.A.) machine is particularly adapted to use by professional well drillers, farmers, contractors, logging operators and underground water surveyors. It is easily transportable, sets up quickly and may be operated by one man without any technical knowledge. It may be operated outdoors or in confined areas like cellars or barns with enough head space.

This well driller may be used alone or mounted on a light truck to make it mobile.

Method of operation

Average speed of this drill is 32 strokes per min. operating through a 4- or 6-in. (9.1- or 15.2-cm.) casing. The machine is equipped with automatic revolving swivel top and driving collar. The full weight of the tool string is thus utilised in drilling.

The 4- or 6-in. casing is designed to take all types of deep well pumps. Only enough casing is required to go through top soil and the underlying subsoil, until it reaches the bed-rock where it is sealed.

The bailer, power operated by the motor through suitable clutches, is periodically used for removing the silt, mud and chips which result from the action of the striking drill bit. Frequent bailing permits the drill to work at maximum efficiency.

The cutting insert for the drill is tungsten carbide, can be resharpened and is easily replaced. Resharpening, however, is needed far less frequently than steel bits.

Specifications

The 4-in. (9.1-cm.) model weighs 450 lb. (204 kg.), has a 6-ft. × 6-ft. (1.8-m. × 1.8-m.) base and stands 8 ft. (2.4 m.) high.

Here the 'Consol' well driller is shown in use mounted on a truck, but it may also be used alone

It is powered with a 1.5 gasolene or ¾-h.p. electric motor, drills through clay and sand at the approximate rate of 4 ft. (12.1 m.) per hour, limestone at 9–15 in. (22.2–38 cm.) per hour, and quartz or hard sandstone at 4–6 in. (9.1–15.2 cm.) per hour. The 6- and 8-in. machines, equipped with an 8-h.p. gasolene engine, drill about 3 ft. (91 cm.) per hour through the hardest rock and proportionally faster through softer formations.

This item was abstracted from *For. Equip. Notes*, E.8.56.

Automatic Oscillation Irrigation Unit

An automatic oscillator irrigation unit has been developed and marketed by the Irrigation Development Co. (Studley) Ltd. This lightweight portable unit is designed to work from normal water mains, rivers, boreholes, ponds or static water tanks. No power unit is required unless the pressure of water is exceptionally low, in which case a specially designed power unit can be supplied. Many lengths in the spray line may be oscillated by one unit. The throw of spray is adjustable up to 22 ft. each side of the pipeline, simulating heavy or fine grain according to requirements. The length of pipeline is dependent upon the amount of water available.

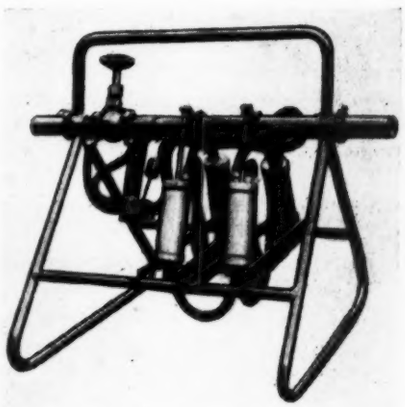
The unit comprises a suitable stand embodying main feed pipe with patent couplings, hydraulic rams regulated by a change-over valve, fed by reinforced rubber hose and controlled by a stopcock. An adjustable leg is provided on the stand for tilting into 'wind.' The pressure of water passing through the main feed pipe of the oscillator is restricted to by-pass through the change-over valve and operate the hydraulic rams. The rams raise the rocker arms fixed to the main supply tube and cause the oscillation of the whole length of coupled pipeline. Once the oscillator has been adjusted to give the required spray, the whole operation functions automatically and continuously.

The oscillator units can in most instances be adapted for use with existing pipelines, but where complete installations are required, standard aluminium pipelines of 15-ft. lengths fitted with jets at 3-ft. intervals are supplied, together with quick action patent couplings and 18-in. pipe stands designed to facilitate easy movement of the lines without uncoupling.

New Oil-fired Heat Exchanger

One of many applications of the COB '300' oil-fired heat-exchanger, recently introduced by Vaporheat Ltd., is for crop drying, including the drying of rubber, coffee, tea and tobacco.

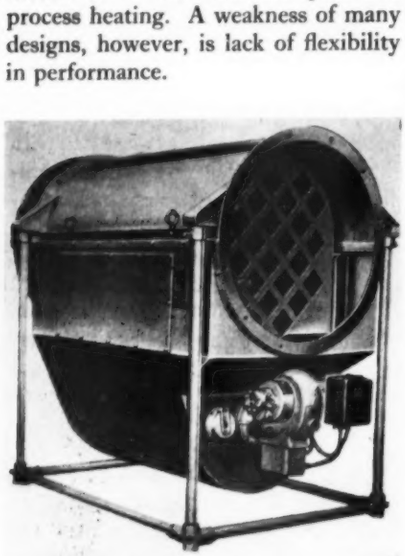
To transmit heat direct from fuel to air is inherently more efficient than through the intermediary of steam or hot water. For that reason, and because it can substantially reduce capital costs,



A lightweight portable automatic oscillator irrigation unit for which no power unit is required, unless the pressure of water is exceptionally low

the oil-fired heat-exchanger has advantages for many applications over steam or hot-water raising plants. Cheaper to install than a boiler installation of comparable output, it requires far less space, eliminates costly ancillary equipment, such as steam traps and valves, and due to its guaranteed efficiency it effects considerable saving in heating costs compared with most other types of equipment.

The American equivalent, the warm air furnace, has been developed far more than in the U.K. for space and process heating. A weakness of many designs, however, is lack of flexibility in performance.



The COB '300' heat-exchanger has been designed for connection to ducted systems and to utilise Woods' 'Aerofoil' fans

The COB heat-exchanger has been designed for connection to ducted systems and to utilise Woods of Colchester 'Aerofoil' fans. The air volume and the pressure developed can be arranged to suit almost any application within the range of volumes from 1,000 to 55,000 cu. ft. per min. and pressures from free air to 20 in. (w.g.).

The COB '300' is the first of a series and has a heat output of 300,000 B.Th.U./hr.

When equipped with a 30-in. 'Aerofoil' single-stage fan running at 1,440 r.p.m. it will deliver 8,000 cu. ft. per min. with an air temperature rise of 34° F., against an external air system resistance of 0.75 in. (w.g.) static pressure.

If supplied with a two-stage 30-in. 'Aerofoil' fan running at 1,470 r.p.m., it will deliver 8,000 cu. ft. per min. with a temperature rise of 34° F., against an air system resistance of 3.5 in. (w.g.) static.

The heat-exchanger chamber, giving horizontal discharge, is fitted each end with drilled fixing flanges of 30-in. internal dia., matching Woods 30-in. 'Aerofoil' fans. It is constructed from heat-resisting stainless steel. The heat source is an M.D.E. Model II fully automatic pressure-jet oil burner. The operation of the unit is completely automatic, the starting and stopping being thermostatically controlled, or by time clock etc.

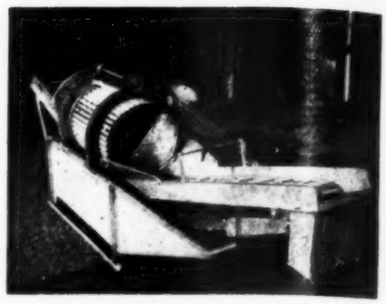
The oil consumption is approximately 2¼ imp. gal./h., the fuel being gas oil having a viscosity of 35 sec. Redwood 1 at 100° F. The heat-exchanger efficiency is 77 to 85%. The unit is supplied complete with an electronic protection relay having photocell flame failure detection for the oil burner, air output temperature control thermostat, fan - and - limit control switch, and special direct - on - line starter with overload protection.

Eye-appeal

Eye-appeal is an essential requirement in merchandising a product and for securing ready sales, particularly when the market is competitive. Spotless vegetables, in sound condition, will naturally appeal to wholesalers and retailers and, most important of all, to the ultimate consumer.

The 'Pylebro' vegetable-washing machine has been specially designed to wash every type of root crop, both large and small, without damage. The freshly dug vegetables are fed into a rotating drum, fitted with spiral tumblers, made of soft rubber. The drum, which is one-third immersed in water, is inclined so that the roots can pass through continuously and be delivered

The 'Ridder Greppelfrees' trench or grip cutting machine. It is drawn by the three-point hydraulic linkage of the tractor



The 'Pylebro' vegetable-washing machine

on to a slatted conveyor, where two jets of clean water give them a final wash over.

The machine uses only a very modest amount of water. The tank holds about 200 gal. (which has to be changed periodically) and the rinsing jets do not use much more than 100 gal. per hour.

There is a large cleaning door for the removal of mud and rubbish and there is a special hoe, provided with the machine, for the removal of adhering silt.

The delivery hopper is fitted with a change-over door, so that two bags may be filled alternately or it may be removed entirely when boxes are to be filled.

The machine may be operated by a 1-h.p. petrol engine or by a ½-h.p. electric motor. It can deal with from 1½ to 2 tons of vegetables per hour, and thus can do the work of about six men, who are thus saved the punishing labour of scrubbing. According to the makers, P. J. Edmonds, the machine saves time and will pay for itself in a reduced labour bill and in better prices for produce.

Trench and Grip Cutting Machine

Trenches of up to approximately 16 in. deep and 10 in. wide can be cut with the 'Ridder Greppelfrees' trench or grip cutting machine, which is suitable to cut and maintain trenches for irrigation, land drainage and sewage disposal schemes. A high-speed cutting wheel, driven by p.t.-o., cuts the trench with tapered sides and a flat bottom and throws the spoil, which is guided by a deflector, either spreading it over a wide area or banking it alongside the trench. A tractor of the Fordson Major class or larger is required to operate the machine, which is attached to the three-point hydraulic linkage.

Agricultural Chemicals

Insecticides: Seed Testing: Anti-freeze Mixtures: Emulsifiers: Trace Elements

Control of Aphid on Hops

An efficient method for controlling aphid and also red spider on hops is described in a folder, recently issued by the Murphy Chemical Co. Control is effected by applying a product, known as ' Terra Sytam,' to the soil and a spray of ' Sytam ' to the plant.

The former is based on bis-dimethylamino fluorphosphine oxide (dimefox) and the latter contains bis-methylamino phosphonous anhydride. Both are true systemic insecticides—they are absorbed into the plant and distributed throughout the plant in the sap and the plant is thus made toxic to aphids for about four weeks. It is claimed that it is selective in action and does not destroy beneficial insects such as ladybirds, lacewings and anthocorids.

The soil is treated and the plant is sprayed in early June when the hops are 6–8 ft. high and before serious attacks of aphid have developed. The roots of newly-planted hops may be damaged if the application is made too soon.

Normally only one application is required and the grower can forget about aphid blight or red spider for the rest of the season. If because of favourable weather conditions the aphid population builds up to a dangerous level in July, it is advised to give an extra application immediately. ' Sytam ' must not be used within five weeks of picking.

It is stated that in many cases hops treated with ' Terra Sytam ' have been more vigorous and heavier crops have been produced. Increases in crop yield ranging from 6% up to as much as 40% have been recorded, both in this country and in Belgium and other European countries, according to the leaflet.

*

Seed Testing

A simple and rapid test to determine the viability of a sample of seed is announced by the Rainbow Colour & Chemical Co. One hundred seeds are counted out from the doubtful stock of seeds and the sample is soaked overnight in tap water at room temperature. The following morning, each seed is cut in half with a razor, one half being discarded and the other retained. The 100 cut seeds are then immersed in a ' Germination Test Solution ' and kept in a dark place for 24 hours. If a red colour is taken up by the embryo it indicates that this seed would have germinated and so the total number of such red-stained seeds indicates the percentage viability.

This 48-hour germination test is claimed by the manufacturers to be applicable to all seeds and bulbs which are large enough to be cut by a razor blade, with the exception of seeds of extremely high oil content. It is further claimed to be over 97% accurate.

The test solution may be used repeatedly until it is exhausted, i.e. a 16-oz. sample is sufficient for 100 germination tests, and if unused it will remain active for six months.

*

Mexican Sulphur

As a result of the steadily increasing demand for agricultural and industrial chemicals during the past few years, Mexico's economy continues to move ahead at an accelerated tempo.

Insecticidas y Fertilizantes Diamond del Norte S.A. is a new company organised to manufacture liquid and dust insecticides.

It will have access to the specialised engineering, research and technical facilities of Diamond Alkali Company, a leading U.S. producer of agricultural and industrial chemicals. (Diamond operates large DDT and BHC production facilities in Texas.)

Another Mexican venture recently formed with this organisation's technical assistance is Diamond Black Leaf de Mexico S.A. de C.V., better known in Mexican commercial circles as ' Diablamex '.

' Diablamex ' operates a completely integrated insecticide-manufacturing plant capable of producing ground sulphur in substantial tonnage. Crude sulphur, produced by Mexican sulphur companies in the Tehuantepec Peninsula, is transported in bulk to the plant, where the material is ground and further conditioned for shipment to agricultural areas.

In addition to providing facilities for producing finished sulphur, suitable for agricultural applications, ' Diablamex ' is adequately equipped to manufacture insecticide concentrates and ready-to-use insecticides in both liquid and dust forms.

*

Anti-freeze Mixtures

Corrosion in the radiators of diesel engines has been found to be due not only to the corrosive constituents in the anti-freeze mixture but also to the generation of electricity when two different metals are joined, or from the motor itself. Such corrosion causes pitting and opens the way for metal failure.

A new anti-freeze mixture, known as ' Amber Anti-Freeze 104 ', is now being produced by Amber Pharmaceuticals Ltd. This is a balanced solution of ethylene glycol with corrosion-preventing chemicals, which maintain the pH above 7.5, i.e. well within the neutral range, so eliminating corrosion due to acidity or electrolytic action. It is suggested that electrolytic corrosion is inhibited by a microfilm. It has also been noted that the water itself showed no tendency to scale, probably owing to the phosphates and other sequestering agents, also contained in the anti-freeze mixture. All that was found was a fine, free-flowing non-adhering sludge.

*

Control of Red Spider

What is ' Akar 338 ' ? It is a new product, based on chlorobenzilate, a Geigy discovery, and is offered for the control of mite, chiefly red spider on fruit, flowers and vegetable crops. It is effective against summer eggs, nymphs and adults of red spider mite but the manufacturers state that it has no ill-effects on predators, the beneficial insects which prey on the spider; they also state that it has no phytotoxic effect on plant foliage or crops, but it should not yet be applied to cucumbers and stone fruits until these have been investigated.

'Akar 338' is said to be perfectly safe to use and no special precautions are necessary when spraying. The spray solution is prepared by diluting the concentrate to 1,000 times its own volume of water.

*

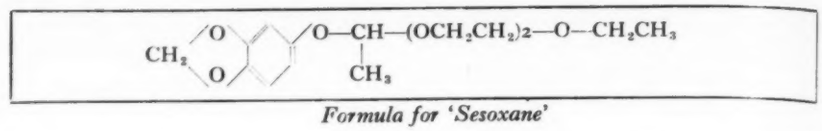
Trace-element Application

One of the important developments in Australia is the establishing of subterranean and other clovers with molybdenum applications by which the lime requirements of the soil are reduced from hundredweights or tons per acre down to pounds per acre.

It is a process by which the seed is coated with lime-molybdenum, using gum arabic as an adhesive and is dusted with a strong rhizobium strain just before sowing. The bacteria are liberally used and about 100–200 lb. of superphosphate per acre are applied at the same time. This permits the rhizobia to invade the legume as it grows by providing a favourable media right at the root.

On certain soils, molybdenum is the chief limiting factor. Without it, you get a sparse scattering of coarse grass; with it, the growth is luxuriant and contains a good stand of sub-clover or other legume in combination with phalaris tuberosa. According to Mr. G. S. Cripps of the Climax Molybdenum Co., it is no exaggeration that the carrying capacity is increased from ¼ sheep to 4 sheep per acre. New areas are being discovered which respond to as little as 2 oz. per acre; several plots have lasted for as long as ten years without the need for further application; in other cases, molybdenum applied within two or three years has given a further response. The subject is being thoroughly investigated by the Commonwealth Scientific and Industrial Research Organisation at Canberra.

It has been established by Mr. M. Takahashi of the University of Hawaii that the correct level of use of sodium molybdate on the islands of Maui, Hawaii, Kauai and Molokai is 5 lb. per acre. Legume and grass combinations do very well, he says, through the application of molybdenum and superphosphate, and it is stated that the grazing capacity is thereby increased twofold. It is suggested that exhausted pineapple lands could support cattle if a programme, embracing controlled grazing, sound fertiliser practice, and the replacement of scrub with a good legume-grass mixture.



Formula for 'Sesoxane'

*

Synergist for Pyrethrin

Shulton's Fine Chemicals Inc. has just announced a new and superior synergist* for pyrethrins and related insecticides, and the product, which is known as 'Sesoxane', is now being manufactured by the company on a pilot scale. It is claimed to be a safe material to apply to insecticides required for use on grains, fruits, and in household and animal sprays.

'Sesoxane' was discovered by Dr. Morton Beroza of the United States Department of Agriculture in Beltsville, Maryland, and the chemical name adopted for the product is 2-(3,4-methylene-dioxyphenoxy)-3,6,-9-trioxaundecane, see formula above.

It is so effective that it is claimed to be cheaper to use than other synergist formulations of equal toxicity. It is readily soluble in kerosene, Freon 11, Freon 12 and other solvents, and is itself a solvent. In consequence, it is easy to formulate in conventional equipment. It has a faint pleasant odour and a low oral toxicity.

*

Mushroom Insecticide

'Basudin' is the name given to a new range of organo-phosphorous insecticides, produced by the same company. Tests made with its active ingredient, diazinon, had shown that it had an outstanding residual effect against susceptible and resistant house flies, and it was decided to try new formulations for the control of the mushroom fly. 'Basudin' 20% mushroom aerosol was the outcome of these tests and this is now offered as an effective control for resistant flies on mushrooms.

The aerosol must be applied by some form of compressor, developing at least 30 lb. per sq. in. The spray is atomised down the main gangway of the mushroom house, with the operator walking backwards.

The use of 'Basudin' need not be dangerous to human beings or animals if elementary precautions are taken. Normally the operator will be moving away from the insecticide, but where the small aerosol gun is used, a mask may be worn to obviate prolonged breathing of the vapour.

*

Toxicant Emulsifiers

In order to obtain toxicant formulations containing a minimum of solvent, Emulsifier 1869 has been developed by Armour and Co. to meet the requirements of manufacturers of herbicides and pesticides. The product is a combination of emulsifiers, blended so as to give maximum effect and stability with both hard and soft waters. It is soluble in aromatic, chlorinated and polar solvents. Two typical formulations are:

Non-solvent system: 90–92% chlordane with 8–10% Emulsifier 1869.

Solvent system: 50% chlordane, 5% Emulsifier 1869, 45% kerosene.

For DDT and lindane, Emulsifier 1905 is recommended in amounts of 1–5% for an emulsion containing 25% of active material and 70–74% of xylol.

In addition, other emulsifiers are available for herbicide concentrates containing solvents. For example, 1–2% of RD 1917 or 1918 may be used in formulations containing 4 lb. acid (2,4-D) per gallon of concentrate. These concentrates may be diluted with kerosene to form clear solutions.

* Synergist: a chemical which co-operates with the insecticide much in the same way as does a catalyst in a chemical reaction.

Reader Service

For further information on any item reviewed in this section please write to:

Reader Service
WORLD CROPS,
Stratford House,
Eden Street, London N.W.1,
England

WORLD CROP REPORTS

INTERNATIONAL

Groundnuts

World production of groundnuts in 1956 is estimated at a record 12.8 million short tons, unshelled basis. This is an increase of 2% from the previous record production of 1955, now revised to 12.5 million tons, and is one-third greater than the average annual pre-war output.

The increase of 270,000 tons from last year is due mainly to the record out-turn expected in *India*. Production in *China–Manchuria* is believed to have increased, but the extent of the expansion is largely speculative. Output in *Africa*, particularly in Nigeria and French West Africa, is not expected to reach the record level of 1955. A record crop of 225,000 tons was reported for the Union of South Africa, where production has tended upward in recent years.

Wheat

Total estimated supplies of wheat in the *Argentine* for the 1955–56 crop year amount to 276.1 million bushels. Comparable 1954–55 supplies totalled 342.9 million bushels. After deducting some 136 million bushels for anticipated domestic requirements, an estimated 140.1 million are available for export and for carry-over during 1955–56, as against 210.6 million available in 1954–55. Total exports of wheat as grain and wheat flour in terms of grain equivalent during the first 10 months (December–September) of the current Argentine crop year amounted to 80.9 million bushels, compared with 108.9 million exported during the same period of 1954–55. The balance remaining on October 1, 1956, for export and for carry-over totalled some 59.2 million bushels, about 42% below the 101.7 million remaining at 1 October, 1955.

The total *Australian* production of wheat in the 1956–57 season is estimated to be 127 million bushels, 35% less than last year, due mainly to reduced acreage. No exports of wheat are likely this year from New South Wales, Australia's biggest wheat State, following a 1956 harvest that was less than half that of previous years. Excessive rain and floods last year cut the N.S.W. wheat acreage to half that of 1955. However, flour extracted from between 12 and 15 million bushels will be exported. Normally N.S.W. exports flour equivalent to 20 million bushels of wheat.

Based on conditions at mid-October, *Canada's* 1956 wheat crop is now estimated at 537.8 million bushels, 9% above last year's out-turn of 494.1 million and 16% above the 10-year 1946–55 average of 463.7 million. While this year's crop is the sixth in seven years to exceed 450 million bushels, it is 23% below the record 701.9 million bushels harvested in 1952. Since the acreage seeded to wheat declined by 1% in 1956, the increase in production is due entirely to higher yields per acre. Yields per acre this year at 25.2 bushels have only been exceeded three times.

The Crop Reporting Board of the U.S. Department of Agriculture reports that, based on conditions at 1 October, production of all wheat in the *U.S.A.* is estimated at 976 million bushels, an increase of 9 million bushels from the 1 September estimate. This is 4% larger than 1955 production, but 15% less than the 1945–54 average. The change from the previous month reflects an increase of about 1 million bushels of durum and an increase of nearly 8 million bushels in other spring wheat. Prospective yield per harvested acre is 19.3 bushels, compared with 19.8 bushels in 1955 and the average of 17.1 bushels.

Sugar

The present standing crop in *Barbados* looks extremely well and a record is expected for the 1957 cutting season. A new type of cane with which experiments are now being undertaken at the British West Indies Sugar-breeding Station is producing more sugar than any variety hitherto tried.

A good crop of Indian high-yielding sugar-cane has been gathered in the To Kiang basin in the western province of Scechuan, *China*, where the planting of this variety was widely adopted this year.

The average yield of 56.25 tons per ha. is 20 to 30% more than from the local native sugar-cane.

The Indian variety was introduced to this important sugar-cane producing region in 1937. Its sugar content is 2 to 3% more than that of the native cane.

The area cultivating this high-yielding sugar-cane reached 7,000 ha. this year, which is equal to one-third of the total sugar-cane area of this region.

Harvesting of the beet crop in the U.K. continues satisfactorily and by the beginning of December some 200,000 tons more beet had been dealt with than had been handled to the same date a year ago, according to the *British Sugar Beet Review*. The crop as a whole is above average, yields in East Anglia being very high, where there is the prospect of an average yield of about 14 tons to the acre.

The *Review* also states that factories were slicing at an average of more than 47,000 tons a day, which exceeds the record set up last season of 45,651 tons. The table given below shows that the sugar content of the root became stable during December at the satisfactory figure of 102 g.

Japanese experts employed by the Seven-Year Plan Organisation for *Persia* have submitted their report regarding the possibility of large-scale

RESULTS OF FACTORY TESTS

Factory tests	*Root weight*		*Sugar content*		*Sugar in root*	
	1956	1955	1956	1955	1956	1955
Week ended:	*g.*	*g.*	%	%	*g.*	*g.*
5 November ..	621	582	15.80	17.05	98	99
12 ,, ..	623	586	15.90	16.92	99	99
19 ,, ..	625	588	15,98	16.84	100	99
26 ,, ..	627	588	16.03	16.79	101	99
3 December ..	629	588	16.09	16.77	101	99
10 ,, ..	629	588	16.14	16.76	102	98
17 ,, ..	629	588	16.18	16.72	102	98
24 ,, ..	630	590	16.20	16.67	102	98
31 ,, ..	631	590	16.19	16.63	102	98

Czarnikow Rev.

production of cane sugar in Khouzistan. They speak of the possibility of producing 200,000 tons of cane sugar within a period of eight to 12 years.

Flaxseed

World production of flaxseed in 1956 is estimated at a near record high of 173 million bushels. This is over one-third larger than last year's output, now revised to 126 million bushels, and 30% above the pre-war average.

Flaxseed output increased from 1955 in all of the major producing areas of the world with the exception of India. The bulk of the 47-million-bushel increase is accounted for by Canada, Argentina and the U.S.A. A sizable expansion also is believed to have occurred in the Soviet Union.

NICARAGUA

Cotton production in Nicaragua during the August–July 1956–57 marketing year is estimated at 180,000 bales (500 lb gross), an increase of 12% from the 1955–56 crop of 160,000 bales, but 12% lower than the record 1954–55 crop of 205,000 bales. Cotton acreage for 1956–57 is estimated at 175,000 acres, down sharply from the 1955–56 area of 257,000 areas and 18% lower than the 1954–55 area of 213,000 acres. The increase in production coincident with a reduction in acreage was a result of greatly improved yields per acre over the very poor yields obtained last year.

The average yield of cotton per acre in 1956–57 is expected to be 494 lb., as compared with only 299 lb. in 1955–56. Unusually heavy rains handicapped land preparation, planting, weed control and effective use of insecticides, resulting in poor stands, overgrowth of weeds and heavy losses through insect pests. Conditions for the 1956–57 crop, however, have been favourable and a return to the higher levels of other recent years is indicated.

TURKEY

The Turkish lemon crop is estimated to be 1.2 million boxes, which would be one-third larger than the 1955 crop of .9 million boxes. The trend in production of lemons and other citrus is expected to continue upward as new plantings and the bearing surface of young trees are increasing. Frosts and lack of adequate irrigation will be the limiting factor in determining the extent of future expansion. Production practices, efficiency of handling and processing are improving rapidly.

Exports of lemons are estimated at about 400,000 boxes. Exports of other citrus are estimated at 100,000 boxes. Most of the lemons are expected to go to Czechoslovakia.

For. Crops & Markets

BRITISH WEST INDIES

The manufacture of starch (including arrowroot starch) in Antigua has been declared to be a pioneer industry and will thus enjoy the privileges which such status carries in respect of taxation and customs duties.

Included in the development programme for the island of St. Lucia is a project for increasing, by some 300 acres annually, the area under cocoa, with a goal of between 3,000 and 4,000 acres in the next 10 years. The crop is regarded as being particularly suited to the climate and soil of St. Lucia and it is of interest that in the first nine months of 1955 a little under 70,000 plants were distributed to growers, as compared with only 560 in 1950.

The demand is growing and it is stated that applications for over 90,000 plants have been received this year, of which about 30,000 had already been delivered in the first half of the September quarter.

PAKISTAN

The first estimate of the area under maize in Pakistan for the year 1956–57 is 1,073,000 acres, as against 1,038,000 acres reported in the corresponding estimate of the previous year.

The general increase in the acreage under maize in West Pakistan is attributed to sufficient rains before sowing and generally favourable soil moisture conditions. The condition of the crop is reported to be satisfactory.

ENGLAND AND WALES

Agricultural conditions in England and Wales on 1 January, 1957, have been summarised by the Ministry of Agriculture, Fisheries and Food.

Conditions were favourable for cultivations and sowing until the weather delayed operations late in December; work is generally as forward as usual at this time of year. Autumn-sown crops are healthy and vigorous. Good progress was made with the harvesting of sugar-beet. Winter keep was drawn on to some extent late in the month and there are shortages in some upland areas.

Weather conditions

The weather during the first week of December was mostly dull with some night frosts and fog, but little rain. More general rain—heavy in places—with high winds occurred during the second week, but milder and brighter conditions followed, although fog became dense in several areas. During the last week it became cold everywhere with sleet and snow spreading over the whole country. It became warmer during the last few days of the month with heavy rain in many districts.

Autumn cultivations

Good progress was made with cultivations and field work, but in many areas rain and snow delayed operations during the latter part of the month. Land worked well on the whole and work is generally as forward as usual at this time of the year. Conditions generally were favourable for corn-drilling and in most areas the acreage intended for winter corn has been sown.

Autumn-sown crops

Wheat has made good growth and looks well, except for some later sowings which have been slow to germinate.

Barley has germinated well and made steady growth.

Oats germinated well and are healthy and vigorous.

Rye looks strong and healthy.

Beans were sown later than usual in many areas and are only just emerging; some earlier sowings have germinated well and are strong and healthy.

Potatoes. Potatoes in stores and clamps are generally keeping well.

Sugar-beet. With the exception of the latter part of the month, conditions for harvesting sugar-beet were good in most areas and a large proportion of the crop has been lifted. Roots are of good quality, but the dirt tare is high.

Pastures

Leys continued to make growth until well into the month and are generally satisfactory.

Permanent pastures provided grazing later than usual in most areas, but some poaching occurred.